

THE UNIVERSITY
OF ILLINOIS
LIBRARY

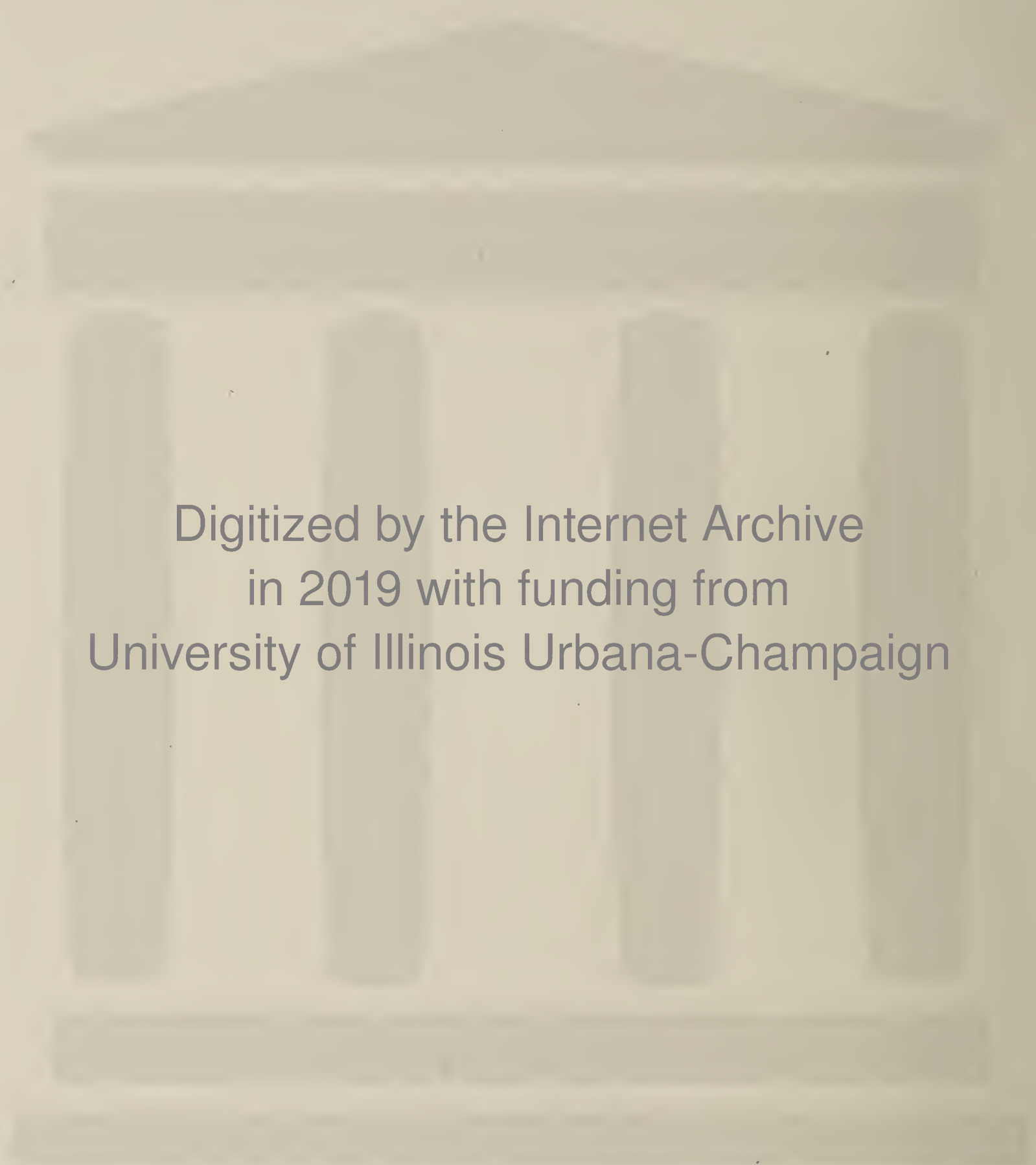
666.05

CE

v.22

REMOTE STORAGE





Digitized by the Internet Archive
in 2019 with funding from
University of Illinois Urbana-Champaign

<https://archive.org/details/cementengineerin2219unse>

CEMENT

— AND —

ENGINEERING NEWS.

Vol. 22. No. 1.

CHICAGO, JANUARY, 1910.

Single Copies 25 cents.

F. L. SMIDTH & CO.

ENGINEERS

50 CHURCH STREET



NEW YORK CITY

Designers, Equippers and Builders of

Portland - Cement - Making Factories

CHICAGO "AA"



1,250,000 Barrels Annually

HIGHEST QUALITY

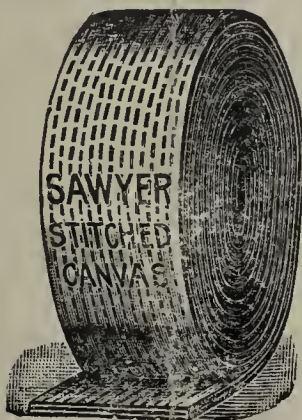
"The Best That Can Be Made"

ENGINEERS and CONTRACTORS who specify nothing but the BEST recognize the superior qualities of "CHICAGO AA" PORTLAND CEMENT and are recommending and using it in all work requiring a strictly high grade and absolutely uniform Portland.

CHICAGO PORTLAND CEMENT CO.

108 LA SALLE STREET CHICAGO, ILL.
(Booklets on Request)

Improved Canvas Stitched Belting



We Specialize in making Belts for use in Cement Plants.

Light or Heavy Transmission, Elevator or Conveyor Belts for Wet, Dry, Hot or Rough conditions.

Sawyer Belting Co.

Cleveland, O.

Send for Book "K."

KRUPP Grinding Machinery

THOS. PROSSER & SON, 24 Platt St., NEW YORK; Old Colony Bldg., CHICAGO

MARQUETTE PORTLAND CEMENT



Made from Pure Rock. Uniform in color, strength and setting time. Used by U. S. Government, leading Architects, Engineers and Contractors

ASK FOR PRINTED MATTER

MARQUETTE CEMENT MFG. CO.

THE STANDARD BRAND

MARQUETTE BUILDING, CHICAGO. Works: La Salle, Ill.



Webster

Continuous Handling Machinery



For Cement Plants

Belt Conveyor with Tripper, 320 feet long, Operating in Cement Plant

Elevate your dividends by lowering your expenses. Install our special machinery which supersedes hand labor and eliminates trouble and expensive delays.

We Design, Manufacture and Install

Main Office and Works:
2410-2432 W. 15th Street.

WEBSTER M'F'G CO.

CHICAGO, ILL.

Branch Offices:
NEW YORK: 88-90 Reade St. PHILADELPHIA: Pennsylvania Bldg.
DENVER: 1720 California St., C. L. Dean, Mgr.
SALT LAKE CITY: Newhouse Bldg., Utah Engineering & Machinery Co.

Milwaukee Bag Co.

MILWAUKEE, WIS.



Manufacturers of

DUCK, OSNABURG and JUTE

Cement Bags

Write for Prices and Samples

MEDUSA Portland Cement

has maintained its reputation for the past fifteen years.

Every barrel tested before shipping



Guaranteed to give perfect results if used correctly.

Annual Capacity:
1,500,000 bbls.

E. A. MOLLAN, Chicago Representative
519 Chamber of Commerce Building

"Portland Cement Sidewalk Construction"

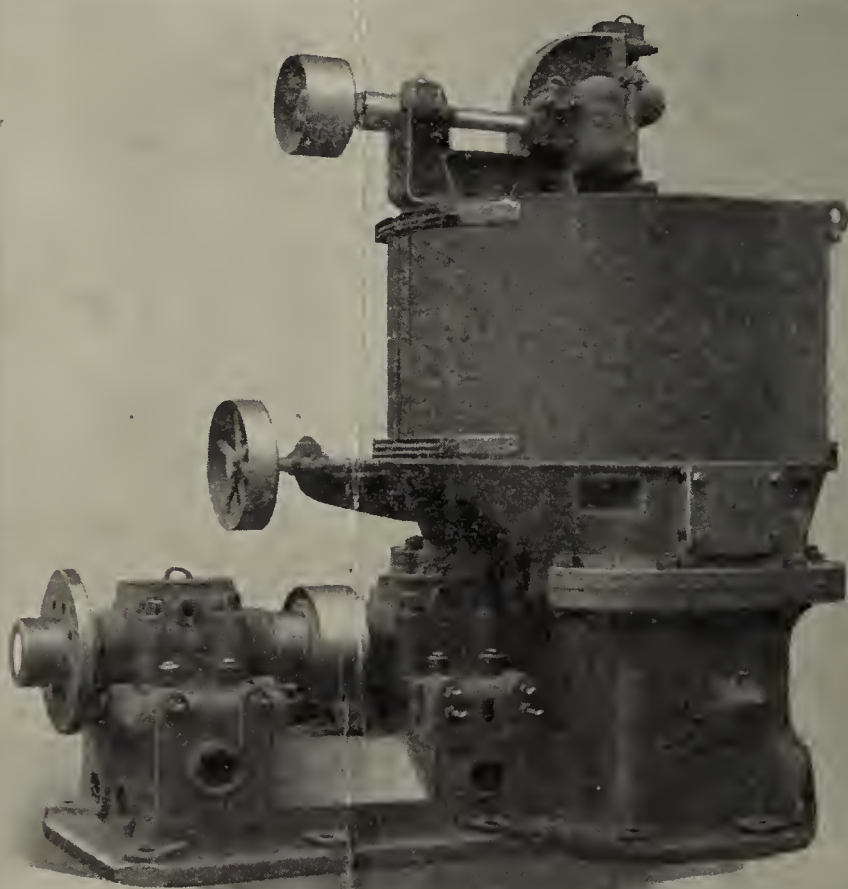
Based upon the experience of many successful contractors.

Compiled by
P. B. BEERY.

PRICE 50 CENTS

Sent to any address on receipt of price.

CEMENT AND ENGINEERING NEWS
32 Fifth Avenue, CHICAGO, ILL.



THE BONNOT Pulverizer

FOR GRINDING
CLINKER,
LIMESTONE
or COAL

12-15 Barrels of
Cement, 6-8 Tons
Limestone per hour

FINEST GRINDING
LOWEST HORSE POWER

Most Convenient for
Renewing Grinding
Parts

The Bonnot
Company

CANTON, OHIO

931 N. Y. LIFE BLDG.,
KANSAS CITY, MO.

HELICOID

Screw Conveyor is heavier, stronger and better made than any other.

Requires fewer repairs—no lapped and riveted joints to come apart—flight all one piece. Special hangers, bearings and boxes for cement work. If you have anything to do with the manufacture of cement, you should write for our No. 84 Catalogue.

Elevating, Conveying and Power-Transmitting Machinery.

H. W. Caldwell & Son Co., 17th Street and Western Ave. **Chicago**

NEW YORK, Fulton Bldg., Hudson Terminal, 50 Church St.

JUST A REMINDER**ATLAS DRYERS—DRY NEARLY EVERYTHING****THE ATLAS DRYER CO., CLEVELAND, OHIO****German-American Port-
land Cement Works****OWL CEMENT**

Illustrated Pamphlet Mailed on Request.

E. L. COX, General Sales Agent,
1527 Marquette Bldg.,

Works: La Salle, Ill. CHICAGO

**ANNOUNCEMENT
TO USERS OF EXPLOSIVES**

We announce with New Year Greetings that arrangements have been made with this Publication to print in this space, during 1910, condensed information regarding explosives. We will endeavor to cover different points in these insertions and believe they will prove interesting and instructive to consumers. For detailed information write to nearest branch office.

E. I. DU PONT DE NEMOURS POWDER CO.
WILMINGTON, DEL., U. S. A.*Send for a copy of these Books***The Hardening of Cement
Under Water** ALSO**The Hardening Process of Hydraulic Cements***By Dr. W. Michaelis, Sr.*

Papers read before the German Portland Cement Manufacturers at Berlin, Germany, March 9, 1909

*Translated by Dr. W. Michaelis, Jr.***PRICE, FIFTY CENTS EACH****Cement & Engineering News, - - 22 Fifth Avenue, Chicago**

Cement Mill Superintendents

who have sat up nights working in the heat and dust of kilns endeavoring to coax red hot clinker elevators into operation

KNOW

Tisco Manganese Steel Chains

PAY

Purchasing agents who keep records of the life of parts

KNOW

that TISCO applications show ultimate economy.

Not how much per foot, but how many thousands of barrels will a dollar's worth of Chain handle!

Detachable Chains for transmission in places of wear and tear.

**TAYLOR IRON & STEEL COMPANY, HIGH BRIDGE
NEW JERSEY**

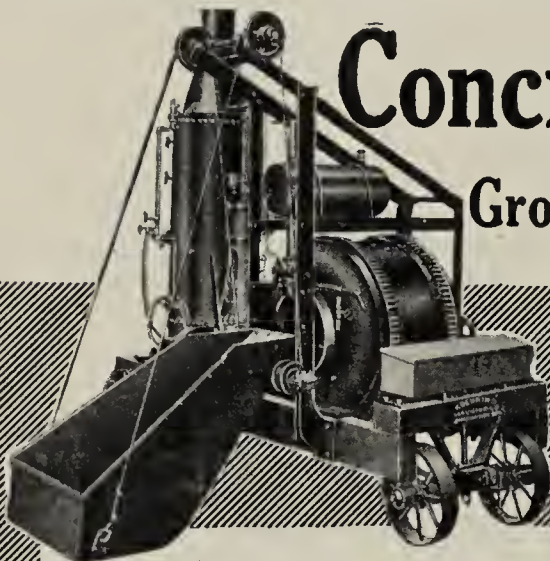


Tisco Combination Chain No. 111

Concrete Mixer Theories

Grow Into Definite Mixing Knowledge

When Every Mixing Action Is A
Known Positive Mechanical Force



There's An Individuality About Koehring Mixing—It's Known Mixing

The drum is a plain cylinder with heavy cast iron heads, but, bear in mind, it's made without *deflecting faces* or other *obstructions* to limit the *end-to-end* mixing.

The mixing blades are so arranged that they not only *lift and pour* the aggregates from the side but carry them alternately from *end-to-end* and *break them over* against the heavy heads.

There's no *guess-work* about it—no rolling over in the center of the drum—every action of the aggregates is performed by a *known, positive mechanical force*.

But there's another mixing than this in the Koehring Mixer.

—When not in discharge position, the inner end of the discharge chute is tilted downward.

—Material carried up by the mixing scoops at the side is discharged onto the inwardly and downwardly extending chute and descends from the inner end in a *continuous flow*; the entire width of the chute, and falls to the bottom at *right angles*, to that from the *mixing scoops* and the *end-to-end* mixing.

That's *three independent mixings*, every one of them a *known mixing* and no *theories* required to explain them.

Three known mixings in one, is why the *Koehring Mixer* is the *fastest in existence*.

But known mixing is not its only improvements over old style batch mixers.

—The trunnion rollers are cast with *wide faces*, *chilled* to extreme hardness and placed wide apart at the extreme ends of the drum.

This not only guarantees a *stable equilibrium* to the drum but insures its maintaining *perfect alignment* even after years of service. The outer end of the discharge chute does not tilt downward, affording ample clearance for wheelbarrows, even in the *smallest* sizes.

There are other *worth considering* features, that every mechanical mind *knows* are correct in principle, explained in our new catalog. Do not fail to write for it at once, being sure to mention "Catalog B."

**KOEHRING MACHINE CO., 614-616 GERMANIA BUILDING
MILWAUKEE, WIS., U. S. A.**

CEMENT BOOKS

How to Use Portland Cement	- - -	50 Cents
Cement Sidewalk Construction	- - -	50 Cents
Hollow Concrete Building Block Construction		50 Cents
Monier Cement & Steel Construction	- -	50 Cents
The Constitution of Hydraulic Cements	-	50 Cents
<i>(By DR. W. MICHAELIS, Sr.)</i>		
The Hardening Process of Hydraulic Cements		50 Cents
<i>(By DR. W. MICHAELIS, Sr.)</i>		
Architects & Engineers Handbook of Reinforced Concrete Construction, Paper Cover	-	\$1.00
Cloth Cover	- - - -	2.50
<i>(By L. J. MENSCH)</i>		

Delivered Free on Receipt of Price.

Address Cement & Engineering News
22 Fifth Avenue, Chicago



None Just as Good

ATLAS PORTLAND CEMENT

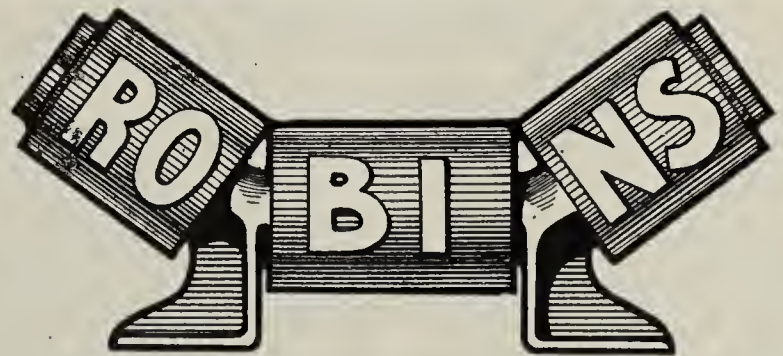
produces uniform work of the best quality. It is not good in one spot and bad in another. It produces a building as permanent, lasting and durable as stone. It gives you a one-piece house, every inch of which is fireproof and sanitary. Be sure you get the right cement—Atlas—the cement of which the United States Government bought 4,500,000 barrels for use in building the Panama Canal.

Send for these Books:

Concrete Houses and Cottages, Vol. 1—Large Houses	\$1.00
Vol. 2—Small Houses	1.00
Concrete Country Residences (out of print)	2.00
Concrete Cottages (sent free)	
Concrete Construction About the Home and On the Farm (sent free)	
Reinforced Concrete in Factory Construction (Delivery Charge)	.10
Concrete in Railroad Construction	1.00
Concrete in Highway Construction	\$1.00
Concrete Garages (sent free)	

THE ATLAS PORTLAND CEMENT CO.
 Dept. 3, 30 Broad St., New York

Largest Output of Any Cement Company in the world—
 Over 50,000 Barrels Per Day.



BELT CONVEYORS

For Use in

Cement Plants

Have No Equal

We have some interesting data on this subject which is yours for the asking.

Robins Conveying Belt Co.

THOMAS ROBINS
 President

Passaic, N. J. C. KEMBLE BALDWIN
 Chief Engineer

NEW YORK

CHICAGO

"Pioneer"

"Safest to use, because richest in Bitumen"

OUR asphaltic products were first introduced in 1896. For 14 years they have been undergoing the hard practical tests of every day use, and Engineers of repute in all parts of the United States are specifying "Pioneer" Asphalt materials today, because these materials have proven superior to all others.

Wherever there is a reservoir to be waterproofed specifications should be adopted which will prohibit the use of an inferior grade of asphalt. Wherever pipe line construction is in progress the question of *protection and preservation* of the pipe ought not to be decided upon mere claims, but the rigid demands of *specifications that are safe* should be enforced as a check upon lax methods and inferior materials.

"Pioneer" Reservoir Waterproofing Asphalt "Pioneer" Mineral Rubber Pipe Coating

Here are two commodities that will meet the demands of the specifications suggested. They are not experimental, but have both been used with the highest success for years, and under the severest conditions.

Over 99½% Pure The superior quality of our asphalts is a *proved-out* proposition—a *known quantity*. Our own mines in Utah contain immense deposits of the purest hydrocarbon known, our Gilsonite analyzing over 99½ per cent pure bitumen. In any true technical comparison of values "Pioneer" Mineral Rubber Pipe Coating and "Pioneer" Reservoir

Waterproofing Asphalt will readily demonstrate the superiority which has made them practically non-competitive. **Specifications** Send for our specifications and be safeguarded against those asphalts (which are offered as being equal to "Pioneer") the employment of which has, in spite of claims, proven them to be inefficient.

The American Asphaltum & Rubber Co.
600-614 Harvester Bldg.,
Chicago, Ill.

A
14
Year
Record
of Success

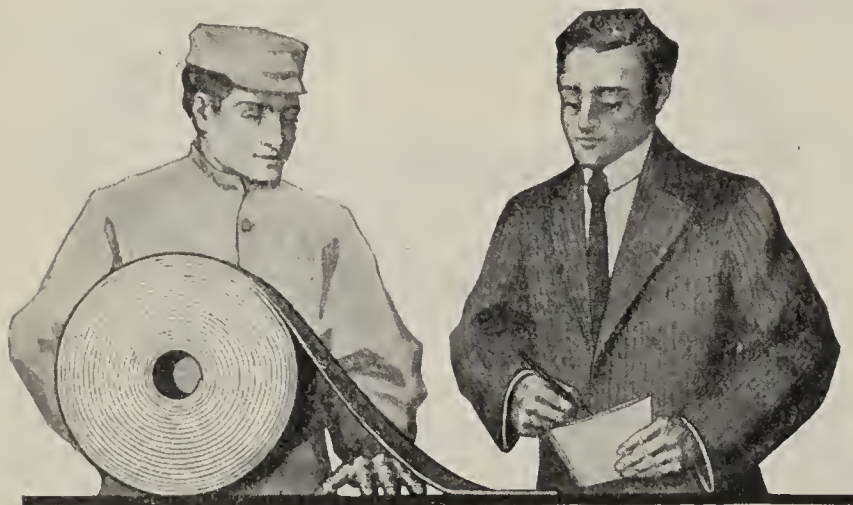


FIGURE THE COST

If one Reliance belt lasts twice as long as two ordinary belts and costs only a trifle more to *buy*, besides giving greater efficiency, needing few if any repairs and causing no trouble, which is the most economical belt to use?

RELIANCE Guaranteed Leather Belting

is the highest quality made. We recommend it especially

For Cement Plants

where it does the severest work without stretching or quickly wearing out. Our broad experience will prove of value to any manufacturer seeking utmost durability and efficiency. Where a waterproof belt is necessary Sea Lion will prove highly satisfactory—we guarantee it.

Write for Booklet.

Chicago Belting Company
12-22 Green St., Chicago

Branches: New Orleans, 431 Gravier St. New York, 71 Dey St.
Portland, Ore., 94 First St. Philadelphia, 234 North Third St.



WATERPROOF-CONCRETE

AT MINIMUM COST

by admixture of

CROWN HYDRATE LIME

Absolutely Safe

CROWN HYDRATE is a basic mineral and contains neither magnesia nor free lime to cause injury by expansion. It will not interfere with final set and hardening of cement, consequently, has no weakening effect on concrete. To the contrary.

THE TENSILE STRENGTH

Of all cement mixtures exposed to air is increased, and the permanent hardness contributed to, giving a structure of tough, rather than brittle texture.

THE PRINCIPLE

Of water-proofing concrete with Crown Hydrate is to fill voids in initial construction and air holes left by evaporation of excess moisture, thus bringing the aggregates to such a density that no water can penetrate.

THE COST

Of Crown Hydrate is extremely low and means but little or no additional expense to secure a cement mixture impervious to water. No extra labor or time is required to apply the hydrate, and aggregates are brought to a maximum density with less effort than in case of straight cement mixtures. The much desired even, white, appearance can be secured at no extra figure and without surface efflorescence.

THE PROBLEM

Of constructing non-expensive, water-proof and white artificial stone is solved by the addition of Crown Hydrate.

REMEMBER, poorly made hydrate containing magnesia is dangerous and may ruin valuable construction. Protect yourself against failure by specifying and insisting on Crown Brand Hydrate Lime.

Manufactured only by

Marblehead Lime Company
KANSAS CITY CHICAGO

CEMENT

.....AND.....

ENGINEERING NEWS



Fig I.—Showing a house of ideal concrete design, where every line suggests a poured building material. s

See page 14.

CEMENT AND ENGINEERING NEWS

[PUBLISHED MONTHLY]

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue

Cable Address—"Seaferts" Chicago.

Entered at the Post Office at Chicago, as Second-class matter, July 21, 1896 under Act of March 3d, 1879.

Subscription	\$2.00 Per Year
Foreign Subscription	\$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON	Advertising Manager
---------------------------	---------------------

CHICAGO, JANUARY, 1910.

TESTING OF CEMENT AND CONCRETE.

It is gratifying to note that engineers are beginning to realize that certain cement tests called for in numerous specifications by railway corporations and other heavy consumers of Portland cement, are not only detrimental to the industry at large, but even a positive injustice to the cement manufacturer, who, after producing and marketing a perfectly sound cement, has it rejected simply because it does not conform to certain antiquated specifications. We refer to the neat cement test called for in the specifications of today, which require that cement, when tested neat, must show a certain increase in strength from 7 to 28 days. On account of this rule, the best cements that the country produced have, in many instances, been rejected for the last decade, merely because the cement, when tested neat, did not show a certain specified increase in strength from 7 to 28 days, although the rejected cement had after 7 days a strength far in excess of the strength which the accepted cement obtained after 28 days or even after 3 months or a year.

In the earlier days of the cement industry, when fine grinding was the exception rather than the rule, this coarsely ground cement would not take on strength as rapidly as at present when fine grinding is the rule. In England some of the cement mills still believe in coarse grinding in order to produce slow hardening; however, in this country fine grinding is demanded. Yet, to call for fine grinding in one part of a specification and for slow hardening in another part of the same specification is inconsistent with the hardening process of Portland cement.

Through the efforts of leading cement experts who occupy commanding positions in the industry, and whose influence is being brought to bear on cement manufacturers, associations and consumers, we are bound to see the neat cement tests abolished, since these tests throw no light upon the behavior of cement in a mortar. Then only mortar mixtures in the proportions of 1 cement to 3 sand and 1 cement to 5 sand will be tolerated. Moreover, these tests will not be considered as decisive, but compression strength tests on at least 3-inch cubes in the case of sand mortars and 6-inch cubes in the case of concrete will be demanded for all purposes, for which a clear insight is desired into the working of the material in actual construction. The reasons for the adoption of these tests are many and are frequently being discussed in American technical journals.

This has been the method of valuation for cement

in Europe for the last fifteen years and should become an international standard rule. As the cement manufacturer of the United States does no longer consider the European manufacturer his competitor, which he was compelled to do in the earlier stages of the American cement industry, more friendly relations are being established every year. The mutual respect of one nation for another has fortunately reached the point, at which the other nation's business affairs are discussed with the greatest eagerness and impartiality. This esteem could be observed particularly during the last few years, at meetings of American cement manufacturers and in the American cement literature, during discussions of the proceedings of the Association of German Portland Cement Manufacturers. The trend of these discussions was an expression of good wishes and a willingness on the part of the American Cement Manufacturer and Cement User to adopt whatever the longer experience of the European cement man had proven to be the proper course to pursue in these matters.

If similar relations continue to prevail in the future, the next meeting of the International Association for Testing of Building Materials, which will be held in New York in 1912, promises to become a very eventful gathering of men of the profession and to result in final decisions of great importance to the mutual advantage of all parties concerned.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.

The annual meeting of the Association of American Portland Cement Manufacturers at the Hotel Astor, New York, on Dec. 13-15, was probably the most successful in the history of the organization. The business meetings were not open to the public, but it is known that there was greater harmony of views regarding trade conditions, the policies that should be pursued to strengthen the public interest in cement and concrete, and to establish the industry on a basis free from injury by irresponsible stock-jobbing schemes, than ever before. A feature of the convention was the retirement of Mr. John B. Lober as president of the association, a position he held since 1903. It is generally felt in the industry of which he is a leader that nobody else has done so much to help along the business interests of the whole cement field as he, and were it not that his physicians have insisted upon his relinquishing many of the responsibilities he has been carrying, the association would not have consented to his resignation of its chief office. He has been succeeded by Mr. W. S. Mallory, of the Edison Portland Cement Co.

There was a public meeting of the association on the morning of Dec. 15 which was opened with a paper by Mr. Robert W. Lesley, giving a review of the recent proceedings of the Society of German Portland Cement Manufacturers. The Society's work is very important to the cement manufacturer, since it reflects in a direct manner the technical problems that are receiving most attention from German cement makers and users; the paper brought out quite distinctly that in many respect progress in Germany and the United States is proceeding along lines of quite similar nature. The next paper was a review by Mr. S. B. Newberry of the work of the association's Technical Committee during the last year. Among the subjects investigated were the effect of oil on concrete, the percolation of oil through concrete, the effect of cold

weather on concrete, methods of determining the fineness of cement particles passing a 200-mesh sieve, and the reasons for cement becoming quick-setting on storage. The report was accompanied by a number of appendices giving in detail information bearing on the subject obtained from various sources. At the close of the discussion of this paper Mr. Logan Waller Page read one on the possibilities of Portland cement as a road material, which attracted unusual attention since it described for the first time the extensive experimental work being carried on under the author's direction in the Office of Public Roads at Washington to ascertain the possibilities of using oil with cement to make a true bituminous concrete. The final paper was a beautifully illustrated description of methods of attaining attractive results in concrete buildings with the least expenditure; it was by Mr. Benjamin A. Howes, a builder who has made a specialty of such work.

THE UTILIZATION OF BLAST-FURNACE SLAG.

By G. B. Waterhouse.

The tonnage of slag produced in the iron blast furnaces of the world is very large. In the United States in 1907 there was produced 25,781,360 long tons of pig iron, which is the greatest production in any year. Assuming that for each ton of iron there is produced one and a quarter tons of slag, which is a conservative estimate, the production for 1907 would be the enormous one of 32,226,700 long tons. The disposal of this large amount of waste material is already a question of serious importance, and is one that will unavoidably become greater as the years pass. Of far greater importance, however, is the question of profitably disposing of it, and the following article deals with the different phases of this subject.

Its chief use at present is as filling around the iron and steel plants; or, after being broken to suitable size, as road material. Many plants also granulate the molten slag by means of water, when it is in very suitable shape for ballast for the railroads. The other methods of utilization, in the order of lesser to that of greater importance, are the manufacture of slag blocks, of slag bricks and of different grades of cement.

Slag Blocks.

With a suitable composition of slag, and under proper conditions as to casting temperature, the kind of the mould, and especially the rate of cooling, blocks can be made that are tough and of excellent wear-resisting quality. They have been made in many countries at various times, and used for different purposes. John Payne, an Englishman, was the first to succeed in making large solid blocks, up to three tons in weight, which were successfully used in making river and canal embankments. According to his method, patented in 1728, the slag was worked with a shovel to free it from entangled gases and air, and at the same time sand or crushed slag was added. The pasty mass was then pressed into cast-iron moulds, lined with sand. As soon as they were hard the blocks were withdrawn from the mould, and cooled down slowly in a bed of sand and charcoal dust. They were also made at an early date in Sweden, for in 1766 a method was given for their preparation. In 1821, at Bolvig, in Norway, blocks one foot long and six inches wide and high, to the number of 40,000 to 50,000 a year, were made for ordinary buildings. The method was to fill the mould loosely with pieces of

slag broken to about walnut size, and then to run in liquid slag. The blocks were removed as soon as possible, and cooled down slowly.

Many attempts have been made to use them for paving blocks. The requirements for this class of material are density, resistance to abrasion, toughness, and a rough surface. By properly varying the character of the mould in which the blocks are cast, and by cooling as slowly as possible, any normal blast-furnace slag can be used, and will give blocks that will fulfill the first three requirements. The chief difficulty is in the slippery surface of a pavement laid with these blocks. One method to produce a rough surface is to use a coarse sand to form the mould; another, and a better one, is to cast the blocks double the size required, and then split them in two along a suitable prepared nick, produced by a projection in the mould. The blocks are then laid with the fractured surface up. The north of England, particularly the Middlesbrough district, has seen the greatest development of this method of utilization.

Slag Bricks.

Several methods have been successfully worked for the manufacture of building bricks from slag. The first were due to the fact that blast-furnace slag, when granulated by being run molten into water, or by having its stream broken up by a stream of water, possesses hydraulic properties. In other words, it is a hydraulic cement, but requires a long time to set. Dr. Lurmann, the well-known German metallurgist, was the first to recognize this, and to utilize it by mixing cream-of-lime with the granulated slag and pressing the mixture into moulds. The lime combined with the free silica in the slag, and, helped by the hydraulic properties of the slag, the bricks hardened by free exposure to the air, in from six to eight weeks.

Considerable attention was paid to this subject in the United States about 1903. The limits for the slag composition were very wide, being:—

Silica	22.5 to 35.0
Alumina and Iron Oxide	16.0 to 21.0
Lime	40.0 to 51.5

The sulphur is harmful and objectionable, and should be kept as low as possible. The slag of suitable composition was granulated, dried, and ground to a fine state of division. Then powdered slaked lime was added to bring the lime percentage to about 55 per cent. The two constituents, after thorough mixing with sufficient water to make a plastic mass, were moulded in a brick press, air dried, and retained for several months, if possible, before marketing.

The bricks varied in color from a grayish white to a dark gray; they were fully equal in strength to ordinary clay bricks, and found a ready sale. Great strides have been made in the manufacture of slag bricks in recent years on the Continent, and many plants are in active operation. There is one also in South Wales at the Landmore Works of Messrs. Baldwins, Limited, and their method and the results obtained may be given in some detail. The capacity is from 25,000 to 45,000 bricks a day, 9 inches by 3 inches by 4¾ inches. There are two buildings, one containing the slag granulator and elevator plant, erected near the blast-furnace plant; the other is larger and is at some distance. It contains a lime-grinding mill with elevator and dust fan, a slag hoist, mixing silo, a preparing or mixing machine, two horizontal brick presses, and three large brick-steaming chambers arranged side by side.

The slag used may vary within wide limits. It

should, preferably, be of a good grey color. It is granulated by being run into a bosh of water of about six times the volume of the slag. This eliminates a great deal of the free sulphur, and gives a friable product, easy to crush. It is flushed down a culvert that empties itself into a receiving chamber at the bottom of the elevator. It is then elevated and passes through a pair of heavy squeezing rollers which separate the excess of water, and crush any coarse particles of slag. From the rolls it drops into hopper trucks and is removed to stock bins in close proximity to the brick works.

The other constituent of the bricks is burnt lime, containing not more than 0.50 per cent of magnesia. It is put through an ordinary jaw crusher, in its unslaked condition, and is then ground in a ball mill to about 100 mesh. This ground lime is then filled into measuring bags or boxes, which are arranged according to the percentage of lime to be used in the succeeding mixture. The lime-grinding room is kept free from dust by a small centrifugal fan.

The slag and unslaked lime are elevated and placed in their proper proportions in a large hopper, at the top of the brick-making building, capable of holding material enough for 1,000 bricks. The proportions are 95 to 93 per cent granulated slag, and 5 to 7 per cent of lime. When full, the hopper is emptied into a steam-jacketed mixer, containing pulverizing blades or paddles, working on the principle of a Green positive-pressure blower. The heat from the steam-jacketed chamber sets up a reaction between the hot lime and the slag. This produces in the material sufficient hardness to enable it to be handled satisfactorily at the brick presses and the hardening chambers. When thoroughly worked, which is perfectly accomplished in from 20 to 25 minutes, the mixture is emptied and fed to the brick presses.

These are so designed that the total pressure is exerted upon the 9 inch by 3 inch face, by the gradual and even approach of two pistons within a press form. One advantage is that being made in this way, the bricks are always of the same thickness. The bricks from the presses are placed on flat-topped trolleys, each holding from 700 to 900. When loaded the trolleys are taken to the steaming chambers, each of which is capable of holding, when fully charged, about 13,000 bricks. The chamber is then closed, supplied with steam at a pressure of 120 pounds to the square inch, and the bricks allowed to stay for about 12 hours. At the end of this time the steam is blown off as completely as possible into the next chamber, which should by this time be standing ready to receive it.

The bricks are then taken out of the chamber and loaded into trucks. When cold they are ready to be used on any construction. When possible, 5 per cent of lime is mixed with granulated slag in a mill, and used as a mortar for setting the bricks.

The bricks have been used with great success in the several plants of the company, replacing the ordinary quality red bricks in the outer walls of open-hearth furnaces, reheating furnaces, boiler settings, and for general building purposes. They have also been used in the building of several chimney stacks working on hot gases. They have proved to be far more refractory than the ordinary red brick. A noteworthy feature in connection with the plant is a hydraulic testing machine, which enables a careful check to be kept of the product. Typical analyses of the slag, and of the product are given in Table I.

TABLE I. ANALYSES OF SLAG AND BRICK.

		Slag.	Brick.
Lime	CaO	34.71	38.34
Silica	SiO ₂	44.03	31.15
Calcium sulphide	CaS	3.69	2.77
Oxide of iron	FeO	.80	.176
Oxide of manganese	MnO	2.16	1.842
Alumina	Al ₂ O ₃	11.40	10.413
Magnesia	MgO	3.10	.....
Carbon di-oxide and combined water	CO ₂	....	13.90

Typical results obtained with these bricks, and ordinary red bricks are given in Table II.

TABLE II. RESULTS OF CRUSHING TESTS.

Material.	Cracked at Lb. per sq. in.	Crushed at
Red brick, wire-cut	250	1200
Red brick, pressed	200	2000
Red brick, pressed	300	1700
Slag brick from steam chambers	2000	2200
Slag brick 9 months old	2000	2200
Slag brick 9 months old	2200	3300
Slag brick 40 months old	2300	2500

The plant employs twenty-three men, three only of whom are skilled, namely, the foreman, the stoker and engineer, and a fitter or blacksmith, and the bricks can be made more cheaply than the red brick with which they will have to compete.

There is another process, the details of which are not at hand, which is said to give excellent results. By it slag is made into bricks without the admixture of lime, cement, or any other binding material. It is based on the fact that silica is rendered ready for combination if exposed to a high steam pressure for a certain length of time.

Cement From Blast-Furnace Slag.

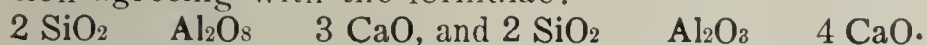
The manufacture of cement from blast-furnace slag is of considerably greater importance than that of either slag blocks or slag bricks, because the cement, weight for weight, sells for a much higher price than either of the other products:

The cements produced may be divided into four classes, which will be taken up in order:

1. The Puzzolan or ordinary slag cement.
2. The true Portland cement.
3. The Eisen-Portland cement, of which a very large quantity is made in Germany.
4. Cements produced by new processes, of which the Colloseus is the most prominent.

The Puzzolan or slag cement takes its name from the Puzzuolana cement. This was the first cement ever made, and was produced from the scoria found at Puzzuoli near Naples. The Romans observed that this scoria, when powdered and mixed with lime and water, would set hard even in water. They used it very largely in their buildings; probably the oldest in which it was employed is the Temple of Castor, erected 496 B. C., and undoubtedly the most famous is the Colosseum, 79 A. D. It was first noted by German chemists that certain blast-furnace slags show a strong similarity in composition to the scoria found at Puzzuoli and neighboring towns, and in 1861 the first artificial Puzzolan was made at the Friedrich Wilhelmshutte. The progress of its manufacture was only slow, owing to its limited field of application. Two of the best known names in connection with the early development of the industry are Tetmajer and Prost. Professor Tetmajer examined many slags as to their suitability for making cement and decided that if the ratio of the lime to the silica was 1.0 or lower, the slag was unsuitable. The lime should be present in a greater ratio. With regard to

the alumina, the best results were obtained with a ratio of alumina to silica of from 0.45 to 0.50. If more alumina than this was present the cement would crack in air. Prost, after many and careful investigations, decided that the hydraulic properties increased as the lime and alumina increased, and he could find no indications of the alumina having harmful properties when present in moderate amounts. He obtained the best results with slags having composition agreeing with the formulae:—



In this place it may be well to mention that Mahon made many careful experiments at the Maryland Steel Company, and obtained his best results with slags rich in lime, the compositions being given in Table III.

TABLE III. SLAGS RECOMMENDED BY MAHON.

	I	2
Silica	30.0	25.3
Alumina	17.0	20.1
Lime	47.5	48.0
Magnesia .....	....	3.28
Sulphur	2.38	2.63

The specifications of the cement department of the Illinois Steel Company were that the slags must be made in a hot furnace, and be light grey. The silica and alumina to be not over 49.0 per cent, the alumina from 13 to 16 per cent, and the magnesia under 4.0 per cent.

There are at present seven plants in the United States making slag cement. They are:

The Struthers Furnace Co. Struthers, Ohio.
 Birmingham Cement Co. Ensley, Ala.
 Southern Cement Co. Birmingham, Ala.
 Ashland Cement Co. Kentucky.
 Stewart Iron Co. (Near Pittsburg) Sharon, Pa.
 One plant at the Brier Hill Co. Youngstown, Ohio.
 One plant at Sydney, Nova Scotia.

The production is not over 500,000 barrels a year.

The process employed is similar at all the plants, only slag must be used which is of suitable composition; as indicated by the specifications given before. It is thoroughly granulated by means of water, and dried by being heated to a dull red heat in rotary drying kilns. The other constituent is slaked lime. The limestone is burned and thoroughly slaked. This lime is added to the slag in varying amounts, depending upon the composition of the slag. Usually from 25 per cent to 35 per cent is added. The lime and slag are thoroughly mixed, one with the other, in tube mills where the mixture is also ground to the desired fineness. The cement is of low specific gravity, from 2.7 to 2.8; it is slow-setting and is especially fitted for work under water or in tunnels, where it is not directly exposed to the air. Its production has not increased, and in Germany it soon went out of favor. A notable exception on the continent is the plant at Konigshofen in Austria, where Puzzolana has been made for fifteen years. It has been used all over Austria and has given such uniformly good results that the Austrian Society of Engineers and Architects has admitted its equality to Portland cement, and allows it to be tested by the same standards. The usual limits of the slag are silica, 24 to 27 per cent; lime, 49 to 54 per cent; alumina, 15 to 19 per cent. From a typical analysis that is given, the ratio of lime to silica is 1.87, and that of alumina to silica 0.60. The slag is, therefore, of exceptionally suitable composition for the manufacture of Puzzolan; 20 per cent of powdered slaked lime is added to the dried and ground granulated slag.

It fulfills all the requirements of a good cement,

showing increased strength with age, sufficient binding power when mixed with more sand than 1:3, good adhesion, good wearing quality, and resistance to weathering. Average figures obtained on the cement at different governmental and private testing institutions show, in standard 1:3 mixture, after seven days, 267 pounds per square inch, and after twenty-eight days, 431 pounds per square inch in tension; and in compression, after twenty-eight days, 4092 pounds per square inch. This is an excellent illustration of the fact that with care an excellent product can be obtained.

Portland Cement.

An excellent cement can be made from blast-furnace slag by using it as one of the raw materials in the manufacture of Portland cement, according to the well-known process. This is the process followed by the Universal Cement Company, the subsidiary of the United States Steel Corporation.

This company has two plants, one at Buffington, near Chicago, which takes slag from the Illinois Steel Company at South Chicago; and one at Universal, near Pittsburgh. The former is, in reality, composed of two plants. In 1904 the production of this grade of Portland was 473,294 barrels; in 1905 it was 1,735,343 barrels, and in 1906 it was 2,076,000 barrels. The capacity has been increased so that now the plants are capable of making considerably more than 10 per cent of the entire production of the United States. The process has also been followed extensively in Germany but has been replaced by the so-called Eisen-Portland, that is to say puzzuolana-Portland cement.

The process of making Portland cement from blast furnace slag followed is to take thoroughly granulated slag, such as would be suitable for Puzzolan, dry it, and grind it. In some places the iron is then separated magnetically. To it is then added the proper amount of dried and ground limestone to give the required final composition of Portland cement. The mixture is then treated exactly as the marl and limestone in an ordinary cement mill, by being sintered in a long, rotating cylindrical kiln fired with powdered dry coal. The clinker is then stored as long as possible, the action of the air slaking any free lime, and also acting on the clinker so that it is much easier to reduce to powder. Finally it is crushed in a preliminary crusher, and then in tube mills to the desired fineness, only such additions being made as in the case of ordinary Portland to regulate the time of setting. With proper care the raw materials can be kept much more uniform than is the case with natural materials, and a product of excellent quality obtained, that easily meets the standard specifications.

By Eisen-Portland the Germans mean a Portland made according to the above method, to which when ground an addition of finely granulated blast-furnace slag is made. Its specific gravity is intermediate between that of Puzzolan or slag cement, and that of Portland, and averages about 3.0. Opinion is greatly divided as to whether the addition of the slag is a benefit or whether it is simply an adulterant. It developed from the theory promulgated by Dr. Michaelis in 1876, that in hardening Portland cement about one-third of the lime present separates as calcium hydrate. This has no strengthening effect, and probably a directly harmful one. It follows that if some substance is added that will unite with this free lime, the quantity of effective cement is raised, and calcium hydro-silicate is formed.

The firm of Albrecht Stein & Co., Wetzlar, fol-

lowed the matter up and made Portland cement from slag and limestone, and with the clinker ground up a certain percentage of dried, granulated blast-furnace slag. For a time this Stein cement met with much opposition, but notwithstanding it increased in popularity, and the method was taken up by other makers. These makers formed an association, known as that of the Eisen-Portland Cement Manufacturers, and agreed that none should mix more than 30 per cent of slag with the clinker. This cement, when set under water, gives as good results as Portland, but in air it sets more slowly. If it can be kept wet for the first few days it gives excellent results.

Ground granulated blast-furnace slag may also, of course, be added to ordinary Portland cement, and in this connection the following table of tests is of interest; 25 per cent of granulated slag was added to 75 per cent of Portland, and thoroughly ground together and briquettes made of one part of this mixture to three of sand, and compared with the cement. The tests were made by Dr. H. Seger and E. Cramer of Berlin.

TABLE IV. TENSION AND COMPRESSION.

Time.	Lbs. per sq. in.							
	Hardened in Air.				Hardened in Water.			
	Tension.	Compression.	Tension.	Compression.	Tension.	Compression.	Tension.	Compression.
7 days..	234	292	1321	1401	210	205	1208	1771
30 days..	356	410	2089	2705	262	271	1553	2046
90 days..	578	616	2884	4107	335	390	3007	3092

The following results show tests on many grades of the Eisen-Portland, covering many months, and obtained in the usual business way. It should be remembered that the German specifications for Portland cement, at the time these tests were made, were 227 pounds in tension and 2,270 pounds in compression, for the 1:3 mixture after 28 days. The Eisen-Portland was satisfactory in regard to fineness, and the accelerated tests. The strength in tension, after twenty-eight days in air, was 390 pounds; in water, 320 pounds; in compression, hardened in air it was 3,331 pounds, and in water, 3,192 pounds, so that it more than came up to the specifications. These results might be multiplied, but they all go to explain the high degree of favor with which this cement is received on the Continent.

Lastly come the methods of cement making introduced in recent years, of which there are very many; prominent among them is the one based on the patents of Dr. H. Colloseus of Germany, and this is the only one that will be described. This process was introduced about three years ago, and was patented in the United States and Canada in 1906, the patents being owned by the Colloseus Cement Company, of New York. It consists of taking molten basic blast-furnace slag, and granulating it by means of a special granulating device, using solutions of alkaline salts instead of water. The special salts are thus intimately mixed with the slag, and the latter is chemically and physically changed, being in the form of a porous clinker easily crushed and powdered. It is in operation at four plants in Germany, one in Scotland, where very extensive and careful trials were made, and in America there are two plants, one at Hamilton, Ont., the other at Buffalo, N. Y., the latter of which is producing cement on a commercial scale. The chief salt used in preparing the solution is magnesium sulphate—crude Epsom salts—and the concentration for general work is 5 per cent. The stream of molten slag falls on to a horizontal ribbed cast-iron drum. This is rotated at 650 revolutions per minute. Be-

tween the ribs are slots through which sprays the granulating solution. In addition, a jet of solution is projected on the drum just below the stream of slag. The slag is granulated and forms little pellets. It is projected with great force on to the water-jacketed casing and falls down either into a buggy, or preferably onto a turn table. The latter affords an opportunity of separating any ungranulated slag that may fall from the spout.

So much solution only is used that the granulated slag is perfectly dry after the operation. The clinker is then treated as in the case of ordinary cement clinker, only such additions being made as is customary, to regulate the setting.

The slags may vary widely in composition, as is evidenced by the following table showing examples of those used at five different plants and giving their analyses in silica, alumina, and lime. The sulphur should be low, and the magnesia below 3.50 to 4.0 per cent.

TABLE V. SLAGS USED IN THE COLLOSEUS PROCESS.

	Bualo.	Porz.	Duisburg.	Harzburg.	Scotland.
Silica	35.05	27.73	35.02	27.56	27.57
Alumina	12.46	12.85	11.08	19.25	17.15
Lime	45.74	52.89	48.86	45.11	46.32

The cement has given excellent results, and it is evident it can be kept remarkably uniform in composition and properties. Some results may be given, obtained on properly identified samples at the famous cement-testing laboratory of Dr. Michaelis in Germany. The specific gravity was 2.97. It showed preliminary set in 19 minutes and final set in 36 minutes. Another sample gave 18 and 43 minutes respectively after four weeks' storage. This shows that Dr. Colloseus has produced a cement that will set quickly, and has overcome the slow-setting quality of granulated slag, which is itself a very slow-setting hydraulic cement. The fineness was very good, as also the constancy of volume. The results of tension were as follows on the fresh cement, and on cement stored for a month; both in the neat state and in the 1:3 mixture.

TABLE VI. RESULTS ON COLLOSEUS CEMENT.

Neat Cement.	Each figure average of ten briquettes.			
	Hardened in Water.		Hardened in Air.	
	Fresh.	Stored	Fresh.	Stored.
3 days	483	508	476	445
7 days	536	560	619	581
28 days	543	593	743	708
1:3 Mixture.				
3 days	233	236	267	253
7 days	274	309	345	316
28 days	285	343	368	389

In several respects this cement possesses qualities that render it superior to standard Portland. It contains absolutely no free lime, and is, therefore, free from expansion; and being made from a completely fused material, has greater fire-resisting qualities.

The Japanese Government sent its experts to Messina, Italy, to study the effects of the earthquake on buildings, and especially on reinforced concrete constructions. The report of Prof. Amore on this subject states "that reinforced concrete showed the best resistance to earthquake shocks. Of two large reservoirs, one of bricks and the other of reinforced concrete, the concrete structure passed through the several earthquake shocks without injury, while the brick reservoir was completely demolished.

RESISTANCE OF CEMENTS TO SEA-WATER INCREASED BY ADMIXTURES OF PUZZUOLANA.

By M. R. Feret.

Translated by Dr. W. Michaelis, Jr.

The foregoing article on the "Utilisation of Blast Furnace Slag" mentioned that admixtures of natural or artificial puzzuolanas to cements, that is to say of volcanic lavas, as for instance puzzuolana proper, trass, santorin earth, and of pulverized or granulated blast furnace slags, have been advocated by Dr. W. Michaelis, Sr. for the last thirty years and that a great industry has been based upon the explanation given by him of the working of these puzzuolanas in connection with slaked lime and cements.

The mixing of puzzuolanas with slaked lime has been practised for thousands of years; it has been the sole application of puzzuolanas until Michaelis taught that, not only lime-mortar could be improved by an admixture of it, thus giving it hydraulic properties, but that also any hydraulic cement, especially hydraulic lime and Portland cement, could be made more water-resisting by admixtures of puzzuolana. By the study of the hardening process of cements had been proven that the hardening of calcined cements was brought about by a process of decomposition, in which a large percentage of the lime of the powdered clinker was transformed into hydrated lime. This latter was easily dissolved in water and washed away in the case of mortars submerged in water thus making the concrete porous. Michaelis, therefore, conceived the idea to bind this hydrated lime by making it act upon finely powdered puzzuolana to be mixed with the cement. Extensive experiments carried on to this effect on a large scale showed that a cement was benefitted the more by similar admixtures the more lime it contained, that is to say that hydraulic limes and Portland cements were those most in need of puzzuolana admixtures. The hydrated lime could now no longer be washed out to the extent it had been done before admixtures were made; as a consequence, the mortars remained denser and resisted the influence of water far better than before, and especially were not apt to be decomposed as rapidly by the action of sea-water, which formerly had free access to the interior of the porous mortar and worked destruction through its contents of magnesium sulphate.

Those familiar with the history of cement manufacture know that this advocacy of puzzuolana admixtures to Portland cement led to one of the most sharp-pointed controversies between the Portland cement manufacturer on the one side and the producers of slag cements (mixtures of hydrated lime and slags), of puzzuolana-Portland cements (mixtures of Portland cement and puzzuolana) and of natural or artificial puzzuolanas on the other side. This war has been waged for thirty years now and is still going on. But, not only the manufacturers and the associations to which they belonged kept up this strife; in time the Governments and engineering institutions of all countries manufacturing and consuming large amounts of cement were drawn into this struggle. The German Government, for instance, ordered tests on a large scale consisting of blocks made under varied conditions and submerged partly in fresh water and partly in sea-water. These experiments were to be continued for a period of thirty years.

The Portland cement manufacturer in all countries

maintained, of course, that his product was the acme of perfection; that it could not possibly be replaced by anything better and that the fact, that many of the marine constructions have withstood the action of sea-water for several decades and were still intact, was ample proof of the high quality of their product. Impartial observers, however, for instance engineers in charge of sea-water canals and fortifications, as well as men of science making a specialty of the properties and the application of cements, thought differently. In their opinion, it was advisable to make a careful study of the relative resistance of different mortars to sea-water and to improve Portland cement by admixtures or to replace it by better cements, if it could be proven that this was possible.

Many thorough experiments have thus been made during the last ten or fifteen years by eminent engineers, some of whom have grown indifferent seeing that large blocks of pure Portland cement concrete successfully withstood the action of sea-water for a number of years as well as blocks made with admixtures of puzzuolana. Others, however, tried to investigate all details of the conditions that had to be fulfilled in order to enable pure Portland cement to withstand the action of the waves and the corrosion by the salts contained in sea-water. As a result of this study, it has been ascertained that most Portland cement concrete is merely protected by a comparatively thin crust of calcium carbonate forming on its surface under the action of the carbonic acid of the atmosphere or dissolved in the water. If by any accident this crust is destroyed, as for instance by the impact of the waves or by the grinding action of pebbles, the sea-water obtains access to the interior and can work destruction until by the formation of a new crust of calcium carbonate sufficient resistance is offered for some length of time.

Whatever the influences may be that fortunately help to retard the action of the sulphates of the sea-water upon the cement, experts were willing to give each of them due credit and, by eliminating one after the other, were bound to arrive at the resistance of the cement itself and to establish a scale of the relative values of the resistance to sea-water of various cements and cement-puzzuolana mixtures. Moreover, they were determined to work out accelerated tests by which these relative values could be ascertained in the course of several months, whereas the method of testing employed so far required as many years.

Through many laborious experiments carried on in this direction, a number of the foremost engineers in Europe were compelled to admit that the advocacy of puzzuolanas, especially of natural puzzuolanas, to Portland cement, as recommended by Michaelis, meant a great improvement over the application of pure Portland cement concrete especially as far as resistance to sea-water was concerned. Perhaps one of the best-known experts in concrete construction, who has convinced himself of the suitability of puzzuolana admixtures and who advises engineers to freely make use of it, after having ascertained the most favorable proportions, is the famous French engineer M. R. Feret, director of the Experimental Station of the Department of Public Works in Boulogne-sur-Mer. In two reports, made during the last years to a special committee of the International Association for the Testing of Building Materials, he published the results of his experiments with puzzuolana admixtures and recommended a method by which, within the shortest time possible, reliable conclusions could be drawn with regard to the relative resistance of hydraulic cements to sea-water.

The importance of these publications will become evident to the reader, if he remembers that admixture of puzzuolana to Portland cement becomes the custom more and more every year and that in Europe, for the past 20 years, a great number of sea-water canals and harbor works, as well as fresh water constructions as bridges, dams, reservoirs and locks, have been built with puzzuolana-Portland cement concrete, which contained Portland cement and puzzuolana in the proportions of about two to one, for instance with a cement containing about 70% of pure Portland cement and 30% of finely powdered artificial puzzuolana, that is to say blast furnace slag. Where natural puzzuolanas have been used, for instance trass, as much as 50 per cent of the Portland cement of the customary concrete mixtures have been replaced by puzzuolana. Thereby the cost of the concrete has been reduced approximately 30 per cent.

With regard to the tests on a large scale made by the German Government, to which we referred in a former paragraph, we may add that these were started in 1896 and were continued at first for two years. This was a preliminary examination involving only tensile and compression strength tests of mortars, that is to say of cement and sand mixtures. As the results of these tests were in favor of puzzuolana admixtures, the German Government ordered, in 1902, long time tests (up to 30 years) and included in these, in addition to mortar tests, also tests on 12-in. concrete cubes. Varying proportions of cement to sand, or cement to sand to crushed stone, were employed, and the Portland cement was replaced, in the case of the puzzuolana tests, by an equal amount of puzzuolana-Portland cement mixtures, consisting of equal parts of Portland cement and trass (a natural puzzuolana found in Germany) in one series of tests, and of 60% of Portland cement and 40% of trass in another series.

Of this long-time series of tests the five years' results have recently been published by the Royal Testing Station of Berlin. The outcome was that, in practically all tests corresponding with actual working conditions, in fresh water as well as in sea-water, and in tensile and compression strength tests alike, both for sand mortars and for concrete, the test pieces containing admixtures of puzzuolanas showed higher strength than those without puzzuolana. Besides, the former were found intact, while the surfaces, edges and corners of a great number of the test pieces of mortars and concrete containing Portland cement without admixtures were found to be badly injured by the sea-water after this period of five years.

Only in rich mortar mixtures, that is to say in the case of mortars of greater density, both kinds of cements employed, namely pure Portland cement and Portland cement with an admixture of puzzuolana, behaved equally well, as far as their resistance to sea-water was concerned, and showed about the same strength.

The deduction to be drawn from these elaborate tests, after submersion in fresh water and sea-water for a period of five years, is that an admixture of puzzuolana to Portland cement is highly advisable, if the proportions of cement to sand, or cement to sand to crushed stone, are to remain the same as customary in concrete construction, and that, for marine construction, mortars and concrete would have to contain about twice as much cement

as customary, if no admixture of puzzuolana is to be made.

Moreover, the tests plainly showed that the mortars and concrete blocks, made from cement without puzzuolana and submerged in sea-water, were protected to some extent by a crust of carbonate of lime forming on their surface, as test pieces submerged 9 days after having been made did not behave as well as those kept in a moist atmosphere for a year before submersion in sea-water.

The economical side of the problem will be realized, if the prices of pure Portland cement and puzzuolana-Portland cement mixtures are compared. A barrel of puzzuolana-Portland cement, consisting of equal parts of a natural puzzuolana and Portland cement, or even only of 40% of the former and 60% of the latter, is, of course, considerably cheaper than a barrel of pure Portland cement in all countries, where a reliable puzzuolana is to be found.

The tests of the German government show, that, in the case of submersion in fresh water, mixtures of puzzuolana-Portland cement (containing equal parts of puzzuolana and Portland cement) and sand in the ratio of 1 to 4, that is to say rather lean mortars, yield exceptionally good results. Consequently a barrel of puzzuolana-Portland cement, containing equal parts of each constituent, is equivalent to a barrel of pure Portland cement. For marine construction, however, requiring richer mortars, if pure Portland cement is to be used, a barrel of puzzuolana-Portland cement, of equal parts of puzzuolana and cement, appears to be equivalent to about two barrels of pure Portland cement, if equal resistance to sea water is demanded for both kinds of cement.

In recognition of the outcome of these five years' tests the German Government has decided that henceforth mixtures of puzzuolana and Portland cement have to be considered as fully equal to pure Portland cement for all kinds of construction work. This ends, as far as Germany is concerned, the fight that the Portland cement manufacturer has put up for the past 30 years. During all this time he demanded that admixtures of puzzuolana to Portland cement should be declared inferior products, whereas the other party rightly termed puzzuolana-Portland cement mixtures "improved Portland cements."

We are indebted for the translation of the following two papers by Mr. M. R. Feret to Dr. W. Michaelis Jr., of Chicago.

Introduction:—Since the time when puzzuolanas were first recommended as suitable admixtures to hydraulic cements with a view to increase their resistance to the decomposing action of sea-water, a series of important researches have been carried on at numerous laboratories, and the subject has likewise been studied on a large scale at some of the experimental stations of Harbor Works.

Although these various experiments have proven so far that no puzzuolana exists which would absolutely protect hydraulic limes and cements against decomposition, it nevertheless must be concluded from them that admixtures of puzzuolanas generally improve the stability of concrete submerged in sea-water to such an extent and in a sufficiently economical way, that their application has to be recommended for marine construction.

The permanent Committee dealing with Cement Materials of the International Association For The

Testing Of Building Materials has, therefore, decided henceforth to make use of admixtures of puzzuolanas on a large scale during actual construction, both on account of the saving resulting from it and in order to obtain a more complete insight into the subject. Before coming to this conclusion, the Committee invited the writer of the present paper to sum up the results of the experiments of the past which may be considered as decisive, and to formulate rules based upon these conclusions, or at least to draw up instructions which would serve as a guide to the engineer who was willing to make use of admixtures of puzzuolanas.

The Principle of Puzzuolana Admixture:—The characteristic property of puzzuolanas, which have been employed for thousands of years, is to supply elements capable of combining with hydrated lime thus yielding mortars hardening under water, even if pure slaked lime is used.

On the other hand, it has been proven that the hardening of hydraulic limes and cements is accompanied by a process of decomposition yielding hydrated lime in uncombined form which, according to the exposure of the mortars to the air or to the water, either combines with carbonic acid, at least on the surface of the blocks, or is dissolved and washed out, thus rendering the mortar porous and subject to decomposition.

By the admixture of puzzuolanas to hydraulic cements this uncombined hydrated lime is supposed to enter into combinations, which not only prevent the cause of the decomposition, but which at the same time contribute to the hardening of the mortar.

That this presumption is true, can be verified by mixing the same cement, in the first place with an inert powdered substance, and in the second place with an equal quantity of puzzuolana, and by a subsequent repeated determination of the uncombined lime in the hardening mortars after weeks and months. In the first case the amount of free lime increases almost indefinitely, while in the second case it decreases very soon.

Density of the Mortars: It has often been remarked that the effect of puzzuolana admixtures is purely of a physical nature and that the increased resistance is solely due to greater density caused by filling out of the voids by the grains of puzzuolana. The determination of the free lime, however, shows that it is due to chemical action. In order to prove that the puzzuolana improves the resistance of the mortar, it suffices to make comparative tests with the same sand and same cement to which, in the first case pulverized puzzuolana has been added and, in the second case the same quantity of an inert material of equal fineness. This results in mortars of the same density, but notwithstanding this fact the former mortar shows greater resistance.

It is certainly true, that in many instances, the admixture of a finely pulverized substance, be it puzzuolana or something else, is able to increase the density of a mortar and consequently its strength. This is the case, if the amount of the large and the medium sized sand grains is more than double the amount of the fine grains, the cement to be included in this calculation. On the other hand, if the fine grains exceed in quantity, it is generally advisable not to further increase the fine by an addition of finely powdered substances. The decrease in density, which would be the consequence of it, would in some measure offset the benefit derived from the admixture of puzzuolana.

This is an experience well to be remembered in

proportioning the aggregates of a mortar; otherwise it will lead to errors.

Setting Time: Owing to the length of time required for the combination of the hydrated lime with most puzzuolanas it happens seldom that their presence materially changes the setting time.

A factor absolutely essential to bring about this combination is the presence of water; therefore, drying out of the mortars must carefully be avoided, at least during the first weeks of hardening.

Strength Obtainable. For this reason, mortars containing admixtures of puzzuolanas obtain as a rule only low strength if they are kept in air and are not protected from drying out. In fresh water they obtain high strength. These figures are ordinarily found to be further increased upon submersion in sea-water, even if the mortars are under water only part of the time, as is the case in tidal water, which does not allow the interior of the mortar to dry out.

The influence of the relative proportions of hydraulic cement, puzzuolana and sand is a very complicated subject; it depends upon both, the above mentioned variations in density and the mutual affinity which cement and puzzuolana exhibit. The best method of studying these various factors consists in the preparing of several sets of mixtures, in which the proportions of the three materials are varied systematically, and in assembling the results obtained and illustrating them graphically on a chart.

Numerous researches made in this direction permit to draw the conclusion that, almost in every instance, a judicious admixture of puzzuolana to hydraulic cements increases their strength and that, in the case of Portland cement and high grade natural puzzuolanas, the most favorable ratio is obtained, if one third of the cement ordinarily used in mortars is replaced by an equal weight of puzzuolana. With other cementing materials the relative proportions of the two active elements giving the best results differ and must be determined in each case by special experiments.

Decomposition by Sea-Water: At the present time we do not possess methods which allow us to test mortars rapidly and safely for their ability to resist sea-water. The results of the experiments made so far have been influenced by secondary processes which, therefore, make their comparison difficult.

However, the experience made by many observers unanimously proves that of the three kinds of mortars made with the same amount of sand and with a given weight of in the first place, pure cement, or, in the second place, a mixture of this cement within a powdered inert substance, or, in the third place, a mixture of the same cement and a high grade of puzzuolana in the same proportions, the second is decomposed first, and then the mortar containing pure cement, while, as a rule, the mortar with an admixture of puzzuolana is decomposed much later.

But it is difficult to give at this time definite rules for ascertaining the best proportions of puzzuolana to cement in each case and to state the relative efficiency of the various kinds of puzzuolanas. It appears, however, that the granulated slags, which frequently give the highest increase in strength, are less valuable than the higher grades of natural puzzuolana as far as their resistance to sea-water is concerned.

Selection of Materials and Proper Proportions: As no fast rules can be established, the best method to pursue at the present time is undoubtedly to use cement and puzzuolana in proportions yielding the maximum strength, that is to say Portland cements in connection with natural puzzuolanas in the ratio of two

parts by weight of cement to one of puzzuolana. This assures from the beginning the highest resistance against physical forces, for mortars with puzzuolana admixtures harden generally more slowly than those made from cements without an admixture.

For the same reason, the selection of the puzzuolana, which, by the way, depends also upon the market price and local freight rates, must be based, for the time being, upon the relative strength shown by tests made with the various materials obtainable. Among those which, in France, may be used to the greatest advantage must be mentioned the high grades of trass, the Roman puzzuolana and especially baked "gaize," which latter will be described in detail in one of the following paragraphs.

The application of granulated slag involves much greater uncertainties. It would not be advisable to use such slags or similar industrial products without having made sure of the uniformity of their composition and that of the manufacturing process from which they derive, and without having made preliminary experiments for the determination of the relative proportions of cement and slag giving the highest strength and greatest resistance after several months' submersion in sea-water.

Preliminary experiments are likewise indispensable, no matter what kind of puzzuolana may be employed, whenever it is to be used in connection with hydraulic lime, as the results of the determination of the most favorable proportions may vary greatly with the nature of the two component parts of the mixture.

An essential feature for an efficient action of the puzzuolana is that the puzzuolana and cement or lime have as many points of contact as possible. This necessitates a fineness of the puzzuolana equalling at least that of the cement and, furthermore, perfect mixing of the two materials. These conditions can easily be obtained, if the mixing is done at the factory before grinding. In this case the quality and the proportions of the materials have to be watched carefully. But, if the mixing shall be done on the premises, convenient devices have to be on hand to effect pulverizing and mixing as thoroughly as is necessary. This, of course, is possible only on buildings of large proportions.

As the mixture of cement and puzzuolana must be of at least the same quality as that of the pure cement, there is no reason for reducing the amount of sand to be used with the mixture. On the other hand, according to our present knowledge, it would be unwise to increase the amount of sand. Thus, there is nothing to be changed in the methods of mixing and application of the concrete. Only special care must be taken, that during the time of hardening preceding the submersion in water the masonry is always kept sufficiently moist.

Finally, in order to profit as much as possible from the experience and to be able to submit further conclusive proofs, every engineer should make comparative tests with concrete blocks made in exactly the same way of the same proportions of crushed stone, sand and cement, but in this case he should use the same brand of cement without admixture of puzzuolana and keep the blocks in well-marked places under the same conditions as the construction work, so that both kinds of concrete can be compared from time to time.

Cost of Concrete: In making use of a cement-puzzuolana mixture, consisting of two-thirds of cement and one-third of puzzuolana, for the manufacture of concrete in the customary proportions, the amount of the aggregates remains exactly the same. Conse-

quently the economy of the application of puzzuolana admixtures consists in reducing the consumption of cement by one-third and in substituting the same amount of puzzuolana for it.

As there are undoubtedly few districts in France, where some kind of good puzzuolana is not considerably cheaper than cement, the application of cement-puzzuolana mixtures is less expensive than that of ordinary concrete.

Gaize: "Gaize" is a soft, grey or greyish-yellow kind of rock, which consists sometimes of nearly pure silica, a great portion of which is soluble. It forms a large part of the Argonne mountain range, where, at some places, it can be found in layers 300 feet thick.

In its natural state it represents a puzzuolana of medium quality, that has the disadvantage of yielding muddy mortars sticking to the trowel and is, therefore, hard to work with. A slight roasting or baking gives it a pink color and remedies this unpleasant feature; at the same time it increases its efficiency and renders it equal to the best puzzuolanas known, especially in regard to the protection of the cements against the decomposing influence of the sea-water.

Owing to its soft and porous nature, the mortars made from a mixture of it with cement possess in the beginning lower strength than those made from pure cement; but, if the mixture of cement and puzzuolana is well proportioned, both mortars are found to have the same strength after having hardened for several months in sea-water; beyond this period the puzzuolana mortars generally surpass those made with cement alone. However, even in the case of the most favorable mixture, namely two parts of cement to one of baked "gaize," it is wise not to figure on an increase in strength and to assume merely equality with ordinary concrete.

The remarkable qualities of this puzzuolana become especially noticeable in the tests on the resistance to sea-water. For this reason, and on account of its abundance and easy exploitation, it seems to deserve the greatest attention and widest application on a large scale.

The "gaize" is not always pure; the lower layers are often adulterated with clay and the upper strata with calcium carbonate; however, in making use of the middle part of the formation, which is of considerable thickness, these adulterations have not to be feared. It is, of course, always advisable to determine its composition by analysis.

Testing of Cement-Puzzuolana Mixtures: In the testing of the cements two cases have to be considered according to whether the puzzuolana is mixed with the cement on the job or at the factory.

In the first case, the specifications for the cement have to be the same as for ordinary cement to be delivered for marine construction, and in addition to this, the quality of the puzzuolana has to be ascertained by special tests.

So far no method of examination which would be applicable indiscriminately to all puzzuolanas, has been adopted by the profession. This question formed the subject of two reports at the meeting of the International Association For The Testing Of Building Materials at Brussels in 1906, from which specifications could very well be drawn up. However, no definite decision has been reached by the Association as yet. In any event, on account of the slowness with which ordinarily the combination of the elements of the puzzuolana with the hydrated lime proceeds, the tests on the strength and on the resistance to sea-water can certainly be conclusive only after a sufficient length of time.

If the mixture of cement and puzzuolana is made at the factory, it is indispensable that the engineer in charge of the construction work knows exactly the composition and exercises a rigorous control over the process of manufacture, which is especially necessary, because the cement used for the cement-puzzuolana mixture can not be subjected separately to the customary tests.

With regard to specifications for cement-puzzuolana mixtures, it is difficult at this time to give absolutely reliable advice. However, the following test on the resistance to sea-water, applicable to pure cements and cement-puzzuolana mixtures alike, can be highly recommended: Although it takes several months, it is certainly one of the most reliable and expeditious.

This test consists in keeping a small block, for instance a briquette of neat cement or neat cement-puzzuolana mixture, in a large volume of water and, at the end of three months, in cutting it down to a rectangular prism, with sides from 1 to 2 centimeters wide, in such a way that at least from 2 to 3 millimeters of the surface of the original block are removed. The prism must present sharp edges and corners. It is now submerged in a solution of magnesium sulphate containing 5 grams of anhydrous salt to the liter, which has to be renewed frequently, and examined from time to time for signs of decomposition.

Most of the cements used nowadays show cracks and fissures in less than two or three weeks, whereas, in the case of cement-puzzuolana mixtures, decomposition generally sets in only after a much longer period. Further details of this method, as well as the results obtained by it with the different kinds of hydraulic cements, are given in a special paper entitled: "Accelerated Method For The Determination Of The Resistance Of Hydraulic Cements To Sea-Water."

Conclusions: In conclusion it may be said, that the application of puzzuolanas in connection with the hydraulic cements used nowadays increases the strength and, in a great number of cases, retards in a remarkable way their decomposition in sea-water. Such admixtures must, therefore, be recommended, but preliminary experiments have to be made in each case in order to ascertain the most favorable proportions.

The principal points to be taken into consideration with regard to the proper application for marine construction are the following.

The puzzuolana must be ground to a fineness equalling that of the hydraulic cement.

The mixing must be done by machinery in such a way that an intimate mixture is secured.

In the case of Portland cement and a high grade of natural puzzuolana, a mixture of two parts by weight of the former to one part of the latter generally gives the best results.

Only such puzzuolanas should be used as have been thoroughly tested. The application of slightly baked "gaize" must be specially recommended.

For all other kinds of hydraulic cements, whatever kind of puzzuolana may be mixed with it, the mixtures must be carefully proportioned by preliminary tests for strength and resistance to sea-water. This rule has to be observed especially in all cases in which the puzzuolana is of a doubtful quality, as for instance in the case of granulated slags or similar industrial waste products.

The proportioning of the aggregates in making mortars and concrete must be done in the same way as in the case of cements without admixture, and the concreting must be done in precisely the same way.

For the sake of obtaining additional information, comparative tests should always be made with mortars or concrete blocks made, under the same conditions and in the same proportions, from pure cement instead of the cement-puzzuolana mixture.

Concrete made with cement-puzzuolana mixtures must be kept moist for some time. This rule, which applies to any other concrete as well if it shall obtain its full strength, should be especially carefully observed.

ACCELERATED METHOD FOR THE DETERMINATION OF THE RESISTANCE OF HYDRAULIC CEMENTS TO SEA-WATER.

By M. R. Feret.

Translated by Dr. W. Michaelis, Jr.

The examination of mortars submerged in sea-water as so far carried out at experimental stations does generally not permit of a comparison of the ability of the various hydraulic cements to resist the decomposing action of salt water. Even if the water is often renewed, the very worst cements alone are decomposed at an early period, whereas the ordinary products can usually be kept for years without showing notable deformations.

In the open sea, it is about the same with this difference that the water has sometimes different effects upon them according to the conditions of the places of exposure.

By working with lean mortars made with fine sand the decomposition can be accelerated, but the effects of it may be veiled by the friable condition of the surface to such an extent that it is often difficult to tell whether the cause of the observed deformation is of a chemical or purely mechanical order.

Experiments made in a continuous current of salt water yield results only, if the mortars are neither too rich nor too lean; moreover, they require a rather complicated installation and their main difficulty consists in obtaining everywhere conditions that permit of comparison with some degree of accuracy.

Another method of increasing the action of the sulphates is based upon an admixture of powdered gypsum to the cement before making it into neat cement pats or mortar and upon submersion in water after the cement has set. This method may be criticized for the reason that it introduces sulphuric acid under abnormal conditions, moreover, before the chemical processes causing the hardness have had time to advance sufficiently, so that this method must be regarded as specially unfavorable to products obtaining their final hardness only slowly.

As far as the tensile and compression strength tests are concerned, they give only little information about the progress of the decomposition, because the strength may steadily increase, even if the test pieces show unmistakable signs of decomposition; on the other hand, perfectly sound test pieces, at least, those of neat cements, may have partly lost their former strength.

The principal reason for the slow progress and the irregular behavior of the ordinary tests for the determination of the decomposition is the formation of a

crust, coating the surface of the blocks, composed mainly of calcium carbonate and magnesium carbonate. This counteracts the diffusion of the hydrated lime towards the surface of the mortar and the renewal, within the pores of the latter, of the sulphates contained in the sea-water. Besides, the formation of this crust seems to depend upon a multitude of circumstances, which explains the apparent difference in the action of the sea-water at different localities.

Vicat eliminated this disturbing influence by placing his mortars, immediately after they were gauged, into air-tight vessels. Then he allowed them to harden for at least a month, opened the receptacles, cut blocks from them possessing sharp edges and corners and submerged them in a solution of magnesium sulphate which was frequently renewed. After various examinations and repeated cleaning with a brush he proceeded, at the end of approximately ten months, to what he called the autopsy of the blocks by sawing or breaking them into two or three pieces and by examining them, if necessary also with a magnifying lens. After this he advised renewed submersion of the pieces in magnesium sulphate.

This method can be simplified without great inconvenience by working with blocks of any shape which have hardened in water, for instance by making use of broken briquettes of neat cement after having determined their strength. Upon having been kept in water for a sufficient length of time, small rectangular prisms are cut from them, whereby the more or less carbonated surfaces must be carefully removed. The faces must be made almost level and be cleaned and must present sharp edges; immediately after this preparation the block is submerged for good in a solution of magnesium sulphate in which it is examined from time to time.

It is advisable to submerge the briquettes in sea-water from the very start, so that the poorest cements can be recognized immediately by some possible decomposition. However, the selection of salt water must not influence the result of the final test and there is nothing in the way of making use of fresh water wherever sea-water can be supplied only with difficulty.

Naturally the test pieces must be submerged in water only after they have set completely.

It is not necessary that the mortars are formed into briquettes; any other form answers the purpose just as well, providing the blocks are not too small.

The application of sand-cement mortars is less commendable than that of neat cements for the final cutting of prisms with sharp edges and corners. Moreover, the nature of the sand and the size of the grains would make a great difference and the specifying of sand of certain chemical and physical properties would unnecessarily complicate the conditions under which the tests are to be made. The most convenient method is to gauge the cement neat to a very plastic consistency.

As to the cutting of the test prisms, the minimum thickness of the surface to be removed from the original block must be determined so, that nothing of the carbonated crust remains. According to the observations of various experimenters, it appears that, in the case of cement pastes of the formerly defined consistency, it suffices to remove everywhere from two to three millimeters of the surface.

The cutting may be started with a chisel, with which the largest pieces can be broken off, then the faces of the prism may be formed at first with a rasp and be finished by careful grinding with moistened

sand of sufficient fineness on a level stone or on a grindstone.

The dimensions of the test prism are of little consequence; if the sides are from 1 to 2 centimeters wide, they offer the advantage of not occupying much space.

It is necessary, however, that the angles are perfectly rectangular, so that the results can be compared, as it is evident, that the decomposition of the cement, which invariably sets in at the edges and corners, must be the more pronounced the more acute the angles are.

The second submersion in water must follow immediately upon the making of the prisms.

It does not appear advisable to use genuine sea-water for this final submersion. In the first place, it is difficult to obtain it at sufficiently close intervals in many localities, and in the second place, its composition differs according to the place from where it is taken; besides, the carbonic acid contained in it, partly dissolved, partly in combination, would coat the surface of the ground test prism with another layer of carbonates, giving rise to new complications. A solution of any soluble sulphate would undoubtedly answer the purpose; however, that of the magnesia has the advantage of introducing, at the same time with the sulphuric acid, the principal element causing the destruction of the mortars, also the magnesia which exists in great abundance in sea-water and which may possibly take a part in this process of decomposition. Comparative tests with different kinds of hydraulic cements prove that the decomposition progresses in every instance more slowly in a concentrated solution of calcium sulphate than in a solution of magnesium sulphate. Furthermore, it is obvious that the action must be the stronger the more concentrated the solution is. However, the value of results obtained with too concentrated solutions may rightly be contested; thus it seems advisable to confine the experiments to a solution containing 5 grams of anhydrous magnesium sulphate per liter ($\frac{1}{2}\%$ solution) which means a concentration slightly in excess of the average salt water.

For dissolving the salt, distilled or boiled water should be used. The blocks must not touch one another and the water must always be kept up to a point several centimeters above them. The receptacles in which the test pieces lie should always be closed tightly so that as little air as possible may have access to them.

Vicat prescribed that the volume of the liquid should be at least eight or ten times that of the test pieces and that the water had to be renewed every day, as long as ammonium oxalate formed heavy precipitates, and every fifth or sixth day from the time when the reagent caused only clouding of the salt water. These rules should be carefully observed also at the present time.

If in spite of all precautions taken the surface of the blocks is found to be coated with a thin adhering film it would be unwise to remove it by brisk rubbing, scratching or washing with acids; the best is in this event to leave it and merely to state the fact in the final report.

Observations ought to be made at least every week during the first months after submersion, later every month, in time at longer intervals and finally once a year. The condition in which the test prism is found should be written down every time, so that, at the end of the experiment, one can form an idea as to the progress of the decomposition. In any event, it is best not to interrupt the experiment before the decomposi-

tion is far enough advanced, and especially not to take down as signs of beginning decomposition anything but deformations that can be verified by further observations, for it happens frequently, that in the course of several subsequent examinations, very slight fissures are believed to be discernible, which later, however, can not be detected again.

The most difficult point was to determine the length of time for which the test pieces had to be kept in their initial bath, before they were to be cut down to prisms and to be submerged in the magnesium sulphate solution. In order to obtain an idea about the influence of the duration of the preliminary submersion, I cut prisms from neat cement briquettes made from all kinds of hydraulic cements; these briquettes were kept in sea-water and were broken after the periods customary for tensile strength tests. The observations made were the following:

In the case of hydraulic cement without puzzuolana admixture, decomposition generally sets in much later at test pieces cut after a preliminary submersion of one week and of four weeks than at those which had been kept in sea-water for at least twelve weeks. The results of the examination after the final submersion in magnesium sulphate showed in the latter case ordinarily only relatively slight deviations which were independent from the duration of the preliminary submersion. The same could be observed at nearly all of the test pieces made from hydraulic lime, grappiers, Portland cement or similar products and quick-setting cements. This is, without doubt, due to the circumstance that, during the first weeks, a sufficient amount of hydrated lime is given off in the course of the decomposing process producing the hardening of these cements, so that, if prisms are cut from them before this formation of hydrated lime nearly ceases, the calcium hydrate, which now continues to diffuse, forms on the surface or in the pores of the test piece new deposits which retard the action of the magnesium sulphate. All experiments, therefore, serve to demonstrate the advisability of waiting at least three months before cutting test prisms from these cements, if the tests are expected to yield results worth comparing and inspiring confidence; this procedure has at the same time the advantage of leading to a more rapid decomposition during the final submersion in the solution of magnesium sulphate.

In the case of slag cements and cement-puzzuolana mixtures, the hardening of which is due, at least partly, to the presence of puzzuolana, the decomposition can often be observed to be the slower the longer the preliminary submersion has lasted. This is easily explained by the general slow progress of the action of the puzzuolana and proves that such mixed cements, if applied in marine construction, become safer with age, owing to the fact that the amount of puzzuolana entering into combination with the substance mixed with it, be it a hydraulic cement or hydrated lime, steadily increases. From this the conclusion must be drawn that, in practical operation, concrete made from cement-puzzuolana mixtures should be submerged in sea-water as late as possible. However, the puzzuolana can act only in the presence of water; for this reason the concrete must be kept moist for the whole time preceeding the submersion in sea-water. Consequently for the testing of the relative resistance of the available cements to salt water the duration of the preliminary submersion should depend upon the conditions prevailing in actual construction. However, for the sake of uniformity of the tests it is necessary to fix a definite period, and it appears to me

that a term of three months may just as well be adopted for these as for other cements. Mixtures which, after this length of time, are not found to be safe enough can certainly be used only in very rare cases for marine construction.

After thus having decided upon a uniform method of testing, a great number of prisms made from mixtures of slaked lime and all kinds of hydraulic cements on the one side and of natural and artificial puzzuolanas on the other were submerged in a solution of magnesium sulphate after varying periods of preliminary submersion in water. In order to facilitate the observations, however, and to make a comparison possible, most prisms were made after three months' preliminary preservation in water. The progress of their decomposition in the solution of magnesium sulphate was observed at regular intervals and the time was tabulated when the first signs of decomposition became noticeable and when complete disintegration set in, as well as many intermediary stages of destruction.

These comparative tests afforded a good insight into the relative ability of the various products to resist the decomposing influence of sea-water.

In the case of the hydraulic limes, the first signs of decomposition generally appear within a month.

For grappier cements this period seems to be longer; however, the samples subjected to these tests originated from a factory turning out especially high grade products.

Slow-setting cements are decomposed in a short time, often in a few days; this is true even of Portland cements which may otherwise answer the severest specifications.

Some of the quick-setting cements behave very well. Unfortunately, however, their rapid action makes them unsuitable for many purposes, especially because it is still unknown upon what depends the great difference in their resistance to sea-water even in the case of samples of almost identical composition.

The slag cements begin to decompose a little later than the Portland cements. Slag cements of a special composition, made from granulated slag possessing itself hydraulic properties give slightly better results.

The cements with admixture of natural puzzuolana remain intact very long, as a rule, without showing any signs of decomposition. In time, however, they disintegrate likewise, but very gradually.

This method of testing, therefore, yields interesting results.

It can be applied easily and, for this reason, offers an excellent guarantee that the tests will be made everywhere under conditions which permit of comparison.

In spite of occupying several months, it must, without exaggeration, be called an accelerated test, especially in comparison to the ordinary method of submersion, which is the only method in general use so far.

The simple reagent selected and the care taken in the elimination of all disturbing influences are convincing evidence that this test admits no other factor but the main cause of the decomposing action of sea-water and, consequently, makes possible to measure the relative resistance of cements to salt water in a trustworthy manner.

Of course, in practical operation, other processes of secondary importance go on at the same time which are able to influence the progress of the decomposition. Thus, for instance, the objection may be made to my method of testing, that it does not take into ac-

count the ability which certain hydraulic cements possess to form protecting crusts earlier than others. But the production of such preventives is a very variable quantity and depends, in a great measure, upon local conditions. The life of the isolating crust is endangered by accidental shocks and by the wear from pebbles kept in perpetual motion by the waves; it is, therefore, absolutely necessary to eliminate such uncertainties in the tests, no matter whether such formations serve to prolong the life of the submerged concrete, as is the general belief, or on the contrary act in the reverse sense, as Le Chatelier believes to have observed in a few exceptional cases.

Conclusions: The following method can safely be recommended for the determination of the relative resistance of the hydraulic cements to the decomposing action of sea-water:

The cement must be gauged neat to represent a plastic dough and be formed into a block several centimeters wide in all directions.

After the cement has set, it must be submerged in water, that has to be renewed from time to time.

At the end of three months rectangular prisms shall be cut from the blocks with sides from 1 to 2 centimeters wide. For this purpose at least from 2 to 3 millimeters of the surface must be removed everywhere; the faces of the prisms should be plane and must represent sharp edges.

After the prisms are made, they must be submerged immediately, within an air-tight receptacle, in a solution of magnesium sulphate containing 5 grams of anhydrous salt per liter, which is to be renewed frequently.

The prisms must be submitted to a careful examination at regular intervals and the time and degree of decomposition must be tabulated.

(The original text contains numerous tables verifying the statements made in this paper.—Editor.)

CONCRETE SURFACE FINISH.

The Artistic Architectural Possibilities of Concrete.

A. D. F. Hamlin.

The principle of reinforcement by means of steel rods, wire mesh, or light bars in truss form has given to concrete a leading place among structural materials. It marks a departure in many essentials from traditional construction, and therefore must exert a like influence upon design. For this reason it has become a subject of absorbing interest in the architectural world, as it presents new problems not only of structure, but also of ornamental and, possibly, even of stylistic expression. The many practical advantages of concrete and the increasing scarcity of lumber assure it a prominent place in the architecture of the future.

Quite a little work which has already been produced is suggestive of appropriate treatment of form and surface. Still, the bulk of concrete building so far has been on purely commercial or engineering lines. We are as yet feeling our way on the outskirts of a new field of design.

Concrete is by no means a new building material, but not until recently did it occupy any but a secondary position. The Romans were the most notable us-

ers of this material, though entirely as a useful substitute for more costly masonry or as a material for rough walls which would be faced with stone or brick. The articulations natural to the latter materials would therefore be expressed; the concrete was merely a backing.

Stucco was sometimes used as a finish for walls. This had been quite a frequent method in still earlier times, and was again later, in the Italian Renaissance, when architectural masonry detail was much imitated in this medium. The same thing is done very frequently to-day.

The stucco building, when it breaks away from being a replica of stonework executed in a cheaper material, tends to develop a plasticity of treatment, a monolithic breadth and surface texture of its own. There is little distinction, as a matter of design, between plastering mortar on walls of brick, clay blocks, or concrete, if the latter is not part of a reinforced monolith. A solid concrete wall is scarcely more than a form of rubble masonry, but one which the fineness of the aggregate makes it easier to render with a presentable surface. But the development of concrete construction has advanced considerably beyond this.

Several methods are now in vogue in which concrete is used, with greater or less completeness, as the structural material. First, there is the above-described stucco on brick or on metal lath over frame. This cannot be classed as concrete architecture, except in so far as it implies some of the same motives to a limited degree, having superficially the plasticity of cement. It is often attractive, but is contradictory, and therefore must borrow and imitate whenever the simple value of surface seems insufficient and form is indulged in.

Then we have concrete block constructions, but this method possesses even less of the real characteristics of concrete. It is, in fact, purely a work in artificial stone. Very few attempts have been made to treat concrete blocks with any artistic sense; when it has been done, however, using large blocks finished to reproduce stone and designing all features just as for stone, it has been shown to be not without scope. However, it is unproductive of new thought in design, beyond the matter of finish to reproduce something else.

The first of the characteristics of concrete as an architectural material is its plasticity. Technical language adopts the term "pouring into the forms," which concisely implies the impressionable nature of the medium, while it describes the actual method of emplacement. Such material calls naturally for molded, flowing forms growing out of the body material, in contrast to the principle of detachment of forms and the putting together of them in small units, which ideas govern architectural construction and ornament in stone. (See Fig. 1.)

Concrete structure is not merely plastic but lends itself to treatment in large masses; it is monolithic. This is the second characteristic of general import, carrying with it the distinction we have just noted. The indication of joints is of course illogical, because such would be merely a pretense of what does not actually exist.

It will be seen from these tendencies that logical form, as it may be expressed architecturally in concrete, makes for severity and simplicity. In all former styles the emphasis of joint lines has been a favorite mode of expression. In this new material plain

surface must be mostly depended upon. Conventional form, as it has been handed down to us, is permeated with the feeling of the cutter's tools. One sees this in the straight lines and sharpness of moldings and in clear-cut carving. Concrete ornament should show evidence of molding rather than sculptural quality. Line has diminished in importance, surface and color has gained. Mechanically, as well as esthetically, the elaborate forms of stone architecture, heavily projected and accurately finished, are contrary to the nature of concrete and the methods used in its erection.

Since so much that has seemed positively essential to design, at least for all large problems where formal elaboration is called for, is denied the concrete designer, he must evidently either veneer the structure with other materials in the same unrelated manner as is done with a steel frame, or must seek other sources of inspiration. A motive prolific in opportunities is

ornament and style will determine the relative value of location and distribution or concentration; capitals, pilaster panels, spandrels, tympana of arches, are natural points for accent. As a general rule, such enrichment is more effective when highly concentrated upon certain central motives of a design and allowed to contrast with expanses of plain surface. One of the limitations of decoration of this type is that it inclines to smallness of scale; thus suggesting its better adaptability to the refinements of a small edifice than to the monumental proportions of a building in the grand manner of the Italian or French tradition. In other words, it is more properly decoration than architecture in a monumental sense.

Fenestration assumes an important place in concrete design. In many compositions there will be an obvious opportunity to strike a contrasting note to plain wall surface by the introduction of richly orna-



Fig. 2. A Large Fireproof Country Residence in California, of Concrete Showing Ornamental Iron-Work in Connection With Concrete Construction.

offered in the use of faience and tile. Pattern is the natural form of enrichment for flat surface, and nothing is more consistently in harmony with the unmechanic and plastic, though durable, surface of concrete than ceramic tile and faience. The tile may be modeled in low relief, or, again, may be mosaic inlays of colored marbles or terra-cottas in geometric patterns. The quality of the concrete surface permits an expression of the hand-made rather than of the mechanically finished.

Color, of course, may be indulged in without stint. To be sure, it is rather fearful to think what may be in store for us in the way of chromatic outbursts should the speculative suburban builder turn his attention to this subject. In any event, polychromy and incrustation or veneering with thin slabs or tiles in appropriate motives are destined to be leading characteristics of concrete design. Recognized laws of

mental metal frames and mullions or sinuous tracery, if the latter would be in harmony with other motives or style used. Wrought-iron balconies, gateways, and lanterns will be valuable accessories. (See Fig. 2.) We believe, too, that hammered copper for certain purposes, such as copings and cornices, may be used not irrationally and certainly with beauty of effect. Of course, where metal is so applied it should be acknowledged and its characteristics emphasized, not disguised.

The finish and texture and tone of concrete surfaces may be varied according to what seems best to harmonize with the character of particular buildings and designs, as will be referred to more at length presently.

Such are some of the motives, full of imaginative promise, that are open to concrete and that should prove, in the problem of the small building, at any rate, an adequate compensation for the forced abstin-

ence from the architectural formalities we have become accustomed to, but which are phrased so entirely in the language of stone.

The treatment of surface is one of the most important matters concerned with the architectural possibilities of concrete. As laid up with care, but purely for utility—a rather wet mixture, well tamped in forms of average regularity, being used—a fairly smooth, but regular surface results, a film of mortar settling against the sides of the mold. However, every irregularity and almost every joint of the boarding leaves an imprint. Patches of exposed aggregates show here and there and variations in color occur in streaks and layers. In short, such a surface is not merely dull and uninteresting; its inconsequent irregularities are objectionable. Several methods are in vogue aiming at the production of an even texture and

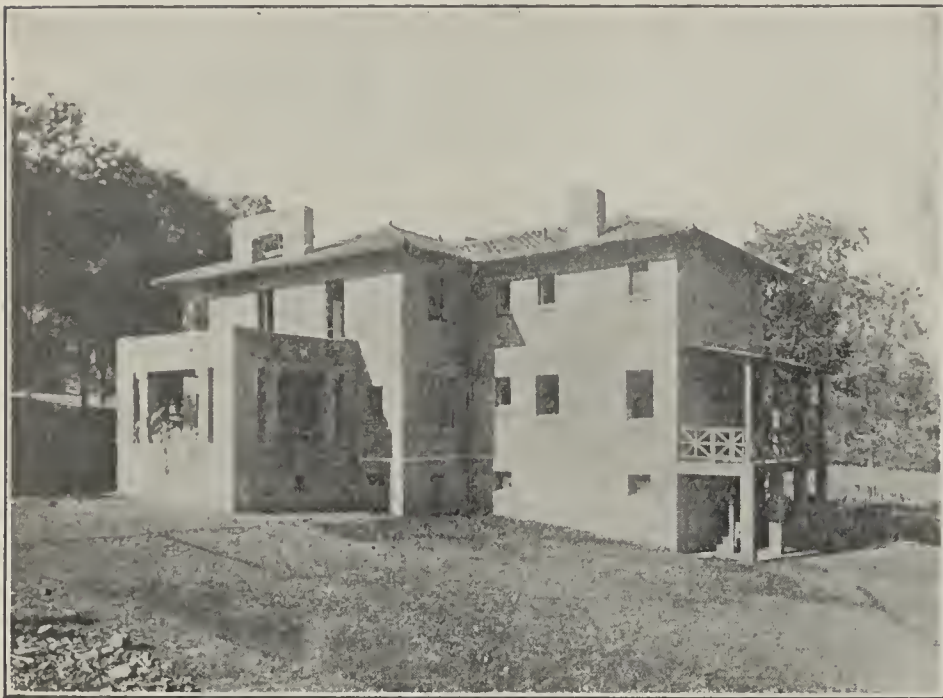


Fig. 3. An Illustration of Scrubbed Surface, Using Muriatic Acid Where the Larger Aggregates Are Exposed.

one agreeable to the eye. Two quite opposite effects may be had; one consists in brushing and washing away the cement skin, thus exposing particles of aggregate; in the other method a surface mixture of selected material is applied to the surface of the molds, just ahead of the pouring of the concrete, and, on removal of the forms, the surface may be further finished by washing or tooling. (See Fig. 3.)

The first of these methods frankly admits and displays the material as concrete. Some very delightful and varied effects may be obtained by using aggregate of graded sizes and mixing in a certain proportion of pebbles, marble screenings, burnt clay, or broken brick, flecks of color thus giving an animated texture to the otherwise leaden and life-less material. Brushing may be done to greater or less depth, giving a more or less roughened surface, as desired. It is necessary to brush and wash the surface while the concrete is still green, as otherwise the process would be too laborious and would be precluded. Therefore the forms must be removed at about twenty-four hours after placing the concrete. The necessity of removing the form work before the concrete has thoroughly hardened considerably limits the practicability of this process. Load-sustaining sections must be hard before the supporting mold is removed from underneath. Where this effect, rather than a smoother finish, is wanted, it should be quite possible to attain it in a measure, even when the concrete is quite hard, by the use of acid and the stone bush hammer. Sufficient of the mortar skin could be removed to obliterate the impres-

sion of board veinings and layer marks, and at the same time expose some of the aggregates. After this tool dressing the wall should be brushed down with dilute acid, followed by water played on by a hose to prevent any stains left by the acid.

Exposed aggregates produce decidedly the most legitimate surface, the only proper finish, it might even be said, where consistent concrete design and ornament is carried out. As a matter of fact, the method is best suited, for practical reasons, to buildings of small dimensions, and, artistically, to those of simple wall composition. (See Fig. 4.)

In the present transitional period, and quite possibly beyond it, a smoother texture, more nearly that of cut stone, will be considered more desirable for many purposes. Such a finish is arrived at by the method known as mortar facing, though it is by no means limited to mortar of the ordinary variety. The most primitive fashion of applying is to trowel on a mortar against the face of the form about an inch thick and for the height of the layer about to be laid and to fill in behind and at once with the ordinary concrete, which, of course, firmly unites with it, as the mortar is still soft. An improvement insuring greater accuracy is to form a slot by means of a sheet-iron plate specially devised for the purpose, with angles to hold it vertically at a desired distance from the face of the forms. The prepared concrete for the facing is first filled into the slot and immediately afterward the backing is poured and tamped down. Then the plate is raised, allowing the two to be firmly bonded together by ramming. When the forms are removed, the facing will require dressing and cleaning down, as, even though the boards have been covered with oil or soap, the soft material will take the impression of grain and joints, and efflorescence may break out in spots. A great variety of texture, and of color as well, may, of course, be achieved according to the aggregates selected: glistening marble, gray trap rock, yellow sand, and brick dust.

A cheaper method, but one not to be recommended, since more permanent finish is possible, consists in applying a skin coat of mortar to the surface after the building is erected and forms have been removed.



Fig. 4. A House Dressed By Hand With Hammer. The Different Shades in the Concrete are Formed by the Various Aggregates Used Going to Compose the Same.

The two principal methods above described, respectively that of outspoken concrete, aggregates showing in relief, and the surfaced-finish, displaying an even, fine texture closely resembling that of cut stone, though it may be coarser, are destined, we think, to characterize two schools of design. Each is in its way legitimate, because harmonious with its own set of ideas and adaptable to widely separated classes of buildings.

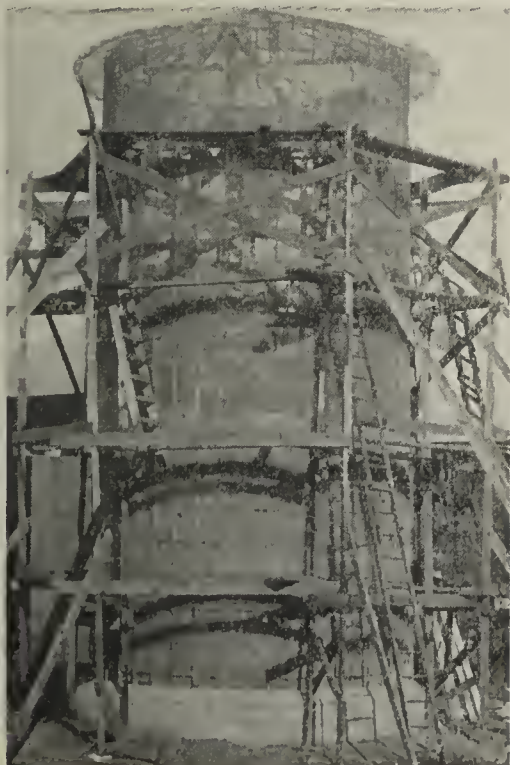
We must come to the conclusion, therefore, that in the treatment of concrete surfaces one thing is to be borne in mind—that concrete should be treated as concrete and not as a cheap imitation of any other building material. Concrete construction lends itself with great facility to almost any class of surface treatment.

In giving descriptions of a few methods, which have been successfully employed, they can be classed under two general heads: First, by the insertion into the concrete of various colored clays or tiles; second, by placing a selected aggregate, in the nature of granolithic finish, on the surface and afterward scrubbing or otherwise treating the concrete surface. Both insertions are made at the time the concrete is placed.

A NEW CONCRETE SILO.

A new concrete silo of an interesting type has recently been erected by the Sharon Steel Hoop Company of Chicago, on the farm of Mr. A. O. Fox at Oregon, Wis. The silo has a steel frame work of slotted steel studding and metal lath, plastered on both sides with cement mortar, making hollow walls of concrete. No wooden forms were used. The steel frame reinforcement consists of galvanized steel studding or channels $2\frac{1}{2}$ inches wide, spaced 12 inches apart. These studs are made from steel hoops and have an interlocking tongue cut out of the center of each upright piece of studding. This tongue is thrown out at right angles and attached to the next stud forming a horizontal line of braces at intervals of every 17 inches in the height of the silo. Expanded metal lath is attached to the studs on both sides of the wall. A waterproofing compound was used on the cement plaster.

The steel frame work was put up complete in three days; an additional day was required to put on the roof. The plastering was done in four days and the silo was filled on the fifth day after its completion.



Construction of Concrete Silo.

Only twelve days elapsed from the time the silo was started until it was filled with silage. The walls of the silo have a continuous hollow wall air space and the steel is galvanized to prevent corrosion; the cost is said to be only a little above the cost of a stave silo.

The ventilating facilities are operated from the



Concrete Silo.

ground on the outside of the silo by an ingenious device, and the structure is provided with the usual doors and entrance on the side and roof.

The makers claim that the silo is quite indestructible, free from the danger of fire and will always maintain a uniform temperature. Universal Portland Cement was used.

PROPORTIONING CRUSHED STONE FOR CONCRETE.

By Albert Moyer, Assoc. Am. Soc. C. E.

A saving in cement and sand may be effected and a much denser concrete obtained if 2 or 3 sizes of crushed stone are used, properly proportioned and mixed together. A simple method is as follows:

Supposing you have two sizes of stone; one passing a $1\frac{1}{2}$ -in. ring, the other passing a $\frac{3}{4}$ -in. mesh. Screen the $\frac{3}{4}$ -in. stone, taking out all that will pass through a $\frac{1}{4}$ -in. mesh, figuring that which is screened out as sand. Make a receptacle which will hold approximately 4 cu. ft., a piece of 15-in. sewer pipe will do. Measure 2 cu. ft. of the smaller stone and 2 cu. ft. of the larger stone, mix them well together with a shovel and place in the receptacle, mark the receptacle on the side the height to which the stone rises.

Empty the receptacle and again measure out $2\frac{1}{2}$ cu. ft. of the larger stone and $1\frac{1}{2}$ cu. ft. of the smaller stone. Mix together as before, place in the receptacle and note on the side the height to which the stone rises. Experiment in this manner, varying the proportion of the larger and smaller stones, always adhering to the total quantity of 4 cu. ft. The mixture which gives the least volume in the receptacle will make the densest concrete, and require the least amount of sand and cement, "Maximum Density is Maximum Strength."

N. B:—Tables and methods of selecting and proportioning sand will be found in Vulcanite Pamphlet No. 6, "Economical Selection and Proportion of Aggregates for Concrete," which will be sent gratuitously.

TRADE NOTES.

The Sawyer Belting Booster for October shows the use of Sawyer belts in cement plants, and gives an interesting testimonial from the Diamond Portland Cement Company, showing what they think of Sawyer belting after a long trial under the most severe conditions.

* * *

H. W. Caldwell & Son Co., engineers, founders and machinists, Western avenue and 17th street, Chicago, have just issued their catalogue No. 34, in which they endeavor to fully and accurately describe the machinery manufactured by this company, although the constant additions and improvements they are making to their line of manufactures makes it impossible to publish a catalogue that will for any length of time show the complete line. The book is 847 pages, bound in cloth, printed on highly calendered paper and profusely illustrated with views of the plant and machinery manufactured by this company.

* * *

Chalmers & Williams, Chicago, Ill., have sold a No. 4 and a No. 6 Kennedy Gyratory Crusher plant to the Winchester Rock and Brick Company, Boston, Mass., and a No. 8 Kennedy Gyratory Crusher plant to the Degnon Contracting Company, New York City,

* * *

Grand Rapids, Wis.—A new company was organized in this city, which will be known as the Carey Concrete Company, and it will engage in the manufacture of concrete brick. The company was organized with a capital stock of \$10,000, fully paid in.

* * *

Somerville, N. Y.—The suburban Concrete Block Company has been incorporated for the manufacture and sale of concrete blocks, with a capital of \$100,000. The officers of the new company are: President, H. F. Dowell, Medford; treasurer, E. R. Hubbard, Somerville.

* * *

The plans prepared by the city of Pittsburg for the proposed new \$1,000,000 bridge across the Allegheny river at the Point have at last been approved by the United States Government engineers, and it is expected that bids will be asked for within a very short time. The masonry will all be of concrete, and there will also be approaches several hundred feet in length constructed of the same material. The cement companies in and represented in this city are already commencing to lay plans for landing the contract for the thousands of barrels that will be used, and there promises to be much competition. There will be retaining walls at each side of the approaches, one of which will be 850 feet in length and the other 894 feet. The bridge will have a concrete floor, with concrete sidewalks for the foot traffic.

* * *

The Western Glazed Cement Pipe & Machinery Co., Lowman Bldg., Seattle, Wash., is a new firm recently organized for the purpose of manufacturing the Thomas sewer pipe machine. This machine turns out a glazed cement sewer pipe, with reinforced bell

ends in all standard sizes from 4 to 24 inches in diameter. The company also makes the pipe for local sale and has recently issued a handsome booklet describing in detail both pipe and machine. This booklet will be sent on request to interested parties.

* * *

Southern Concrete Products Company, of Washington, D. C., has been incorporated to manufacture and sell concrete and like products. The capital stock is \$250,000, of which \$200,000 is common and \$50,000 preferred stock. The incorporators are William A. Kennedy, Charles H. Galliher, Clarence T. Kingsbury, Frank L. Averill and Fred Drew, all of Washington, D. C.

* * *

The Tishomingo Stone and Concrete Co., of Jackson, Miss., has been incorporated with a capital stock of \$200,000 by Edward Mayes, J. C. Longstreet, and a number of others, for general manufacturing purposes.

* * *

Los Angeles, Cal.—Plans for the manufacture of interlocking cement roofings of all colors will be established in Los Angeles, San Francisco, Portland, Seattle, and Spokane by the Payne Cement & Tile Co., which has been incorporated in Los Angeles, Cal., with a capital of \$150,000, by B. E. Payne and associates. The company will build a temporary plant on Benefit St., Los Angeles, and will establish a permanent factory later, on property adjoining the Los Angeles River.

* * *

At its second annual convention in Philadelphia last week the American Institute of Chemical Engineers elected the following officers: President, Charles F. McKenna, New York; vice-president, E. G. Acheson, Niagara Falls, and Eugene Haanel, Ottawa; secretary, John C. Olsen, Brooklyn; treasurer, William M. Booth, Syracuse; directors, Samuel P. Sadtler, Philadelphia; William M. Grosvenor, New York, and Richard K. Meade, Easton, Pa. The next convention will be held in Toronto.

BOOK REVIEWS.

Concrete Pottery and Garden Furniture by Ralph C. Davison, 16mo. (5¼x7½ inches). 196 pages. 140 illustrations. Price \$1.50 Postpaid. Munn & Co., Publishers, 361 Broadway, New York, N. Y.

This work should appeal strongly to all of those interested in ornamental concrete as the author has taken up and explained in detail in a most practical manner the various methods of casting concrete into ornamental shapes. The titles of the thirteen chapters of which the book is composed will give a general idea of the broad character of the work. The first two chapters explain a most unique and original method of working pottery which has been developed by the Author. They are entitled:

I. Making Wire Forms or Frames. II. Covering the Wire Frames and Modeling the Cement Mortar into Form. The remaining eleven chapters are as follows:

III. Plaster Molds for Simple Forms. IV. Plaster Molds for Objects Having Curved Outlines. V. Combination of Casting and Modeling—A Egyptian Vase. VI. Glue Molds. VII. Colored Cements and Methods Used for Producing Designs with Same. VIII. Selection of Aggregates. IX. Wooden Molds—Ornamental Flower Pots Modeled by Hand and Inlaid with Colored Tile. X. Concrete Pedestals. XI. Concrete

Benches. XII. Concrete Fences. XIII. Miscellaneous, including Tools, Waterproofing and Reinforcing.

CEMENT MILL NEWS.

The cement works at Wayland, N. Y., which for the past 16 years has been owned and operated by the Thomas Miller Company, of Syracuse, has been sold to the Wayland Portland Cement Co. This company was organized by all local men for the purpose of buying and operating the plant. The officers are John Kimmel, president; F. K. Smith, vice-president; F. C. Lander, treasurer; and O. F. Kiefer, secretary and manager.

The Freeborn Engineering & Construction Company, of Kansas City, Mo., has recently placed an order with Allis-Chalmers Company for additional machinery for the cement plant at Hartshorne, Okla. This will consist of a 27'x9' ball tube mill, with balls, capable of turning out over 60 bbls. per hour of finished material, and one 8'x26' tube mill.

Claiming that it has failed to receive payment for its work and material furnished in the construction of the big plant of the Iowa Portland Cement company, the Des Moines Bridge & Iron Works to-day filed suit in the district court against the concern for \$36,356.

The Chicago Portland Cement Co. has placed an order with the Power and Mining Machinery Co., of Cudahy, Wis., for a No. 42 crusher.

The Southern States Portland Cement Company, of Rockmart, Ga., is increasing the capacity of its plant by adding a 5'x20' Gates dry-grinding tube mill with silex lining. The mill will be driven through a spur gear by a 75 H. P., 700 R. P. M., 550 volt, 25 cycle 3-phase motor, designed especially to give high starting torque. This equipment will be manufactured by Allis-Chalmers Company and is a duplicate of eleven mills previously furnished by the same company.

The Dewey Portland Cement Company, of Kansas City, Mo., has contracted with Allis-Chalmers for two 6'x22' Gates dry-grinding tube mills for their plant at Dewey, Okla.

The Security Cement & Lime Company, of Baltimore, Md., have recently purchased one No. 9 and two No. 6 Kennedy Gyratory Crushers from Chalmers & Williams, of Chicago.

Mason City, Ia.—A million and a half barrels of cement have been the output of the Northwestern States Cement company here since February last. The mill closed to-day for six weeks for general repairs.

The mill has been turning out the finished product at the rate of 3,500 barrels per day, the highest average of any of the seven big mills owned by one company in different parts of the United States. It required over 325 trains to handle this product, and to make it over seventy-five train loads of coal were consumed. Most of the cement made here was sold in the northwest, Minnesota taking the bulk of the output, and Iowa ranking next.

Wellington, Kans.—Acting under instructions from

Attorney General Jackson, County Attorney Herrick to-day filed suit in the district court against the Western States Portland Cement company and L. E. Barbour, a local material dealer. The information, which consists of three counts, charges that the defendants enlisted into a combination to fix the prices of Portland cement at this point. The suit is designed as a test case to ascertain whether, under the Kansas anti-trust law, a combination can be enlined into by individuals and corporations to fix the price of an article in common use.

ANNOUNCEMENT.

The Western States Portland Cement Company announces the resignation, on account of ill health, of Mr. T. F. McClaren who, until recently, has been in charge of Sales. In this connection we are pleased to state we have arranged with Mr. E. R. Stapleton, formerly with the Iola Portland Cement Company to take charge of the sales and marketing of our product and because of his many years' experience and large and favorable acquaintance with the trade, feel certain we will be able to take the very best care of our friends' and patrons' needs and requirements.

WASHINGTON CEMENT SURVEY.

Prof. Solon Shedd, assistant state geologist, professor of geology in Washington college, and in charge of the cement material survey of the state, finished his work in the western part of the state and departed for eastern Washington, where his work is not yet completed. He has been assisted by A. A. Hammer, a graduate of the state college. Professor Shedd has found numerous cement areas in the state, many of them cropping out in unexpected places. According to his statement, at the junction of the Grande Ronde and the Snake rivers there is a large deposit of shales and limestone that to all appearances will make good cement. Down the Pend Oreille river, near the towns of Ione, Cement and Metalline, he observed large deposits of limestone and shales and some clays. Considerable development work has been done in the vicinity of Metalline. A little cement has been made at Cement. Shales, limestones and clays occur in the vicinity of Colville and Kettle Falls, also along the Columbia river. Near Bossburg, Ryan and Northport large deposits of limestone shale and clays are found. In Okanogan county Mr. Hammer found some limestone.

On the west side of the Cascades the geologists found some limestone in the vicinity of Kendall and Maple Falls, on the Nooksack river. At the towns of Baker and Concrete the deposits of limestone and clay are large. Also large deposits of limestone and clay were found a few miles up Jackson creek, above Concrete. Still further up the Skagit, near Rockport, a deposit of limestone occurs.

The San Juan islands were the last places examined. Here deposits of limestone and clay were seen on Orcas, San Juan and Lopez islands. A large deposit of limestone occurs at Roche Harbor and is being operated by the Roche Harbor Limestone Company, where a great deal of lime is being burned.

Professor Shedd thinks that the cement industry should assume large proportions in the state. While large and numerous areas of limestone, shales and clays were examined during the course of the summer field work, it will be necessary to make chemical analyses and experimental tests to determine the value of the various deposits.

NEW CEMENT MILLS TO BE BUILT.

The Great Lakes Portland Cement Co., with offices in the Mitchell Bldg., Milwaukee, Wis., is soon to begin work on its new plant near St. Ignace, Mich. An interesting booklet has been issued by the company with the title, "Remarkable Showing of the Portland Cement Industry." This book contains statements showing financial condition of a great many Portland cement plants now in operation and it also gives detailed information regarding the situation of the Great Lakes plant. The booklet will be mailed free to any address on request.

The Oklahoma City Portland Cement Co., Oklahoma City, Okla., is making rapid progress with its new plant at Hartshorne, Okla. The Freeborn Engineering Co. has 118 men at work on the buildings and is also installing the crushers. The railroad from Hartshorne to the plant is being built and will soon be ready to haul the heavy machinery for the plant. Over 250,000 cubic yards of crushed rock are contracted for, for railroad ballast and other work. The company expects to be ready to market its cement in the spring of 1910.

F. A. Aldrich, of Detroit, Mich., is president of the newly organized Standard Cement & Lime Co., which incorporated this week with a capitalization of \$1,000,000. It is said that one-half of this amount has been raised.

The plan is to erect a plant to cost about \$700,000 at Charlevoix where the company has 1,000 acres of quarry and shale property. The site is on Lake Michigan and a 500-foot dock will be built in 24 feet of water. It is expected the plant will be ready for operation Sept. 1, 1910.

Henry E. Hunt, of Coldwater, is vice president and E. L. Buell, of Detroit, secretary and treasurer, Messrs. Hunt and Buell are the principal stockholders.

Spokane, Wash.—New York, Chicago and Spokane capitalists have financed the People's Portland Cement company, incorporated for \$2,000,000, to erect and operate a 2,000 barrel plant, costing \$500,000, at Squaw bay on Lake Pend Oreille, sixty miles north-east of Spokane. Arthur S. Ford of New York and H. A. Groth, of Chicago, announce that contracts will be awarded in a few days for a steel and concrete plant, with three kilns, to be in operation next August, when cement will be laid down in Spokane at \$2 a barrel.

The present cost of cement, of which more than 1,000,000 barrels is used annually in Spokane and the adjoining territory, is from \$2.75 to \$3.50 a barrel, including freight charges, the bulk of the supply coming from Kansas and Canada.

Through Mr. Ford the company has acquired 350 acres of limestone lands on Lake Pend Oreille, where ample steam and electric railway and steamboat facilities will be afforded as soon as the plant is in operation. A town will be established near the millsite the coming spring and every building in it will be of concrete construction.

The Alpha Cement Co., Easton, Pa., are planning to increase the capacity of their plant at Cementon from six to fifteen kilns according to press reports. This will necessitate the employment of double the force now engaged.

The Marengo Portland Cement Co., Caledonia, N. Y., has closed down for the winter, during which time two new kilns will be added and numerous repairs and alterations made.

Following a two-days' stay at the plant President and General Manager G. W. Hackett, of the Castalia Portland Cement Co., announcement was made of plans for extensive improvements and an enlargement of the plant.

The capacity of the mills is to be increased 33 per cent and \$50,000 will be spent for improvements in the wet and dry grinding departments. Extensions to buildings will be erected and new machinery will be installed. The work is to be commenced at once so that the enlarged plant will be ready for operations in the spring.

With the additions to be built, the plant will have a total annual capacity of between 500,000 and 600,000 barrels. This is made necessary, it is stated, by the demands for the product, the prospects being better than at any time in the last five years. Already orders for delivery early in the year are being turned down because the mills cannot fill them.

R. E. Leach, who has been superintendent of the plant, is no longer connected with the company and his successor has not been appointed. President Hackett expects to spend the greater part of his time in Castalia, giving his personal attention to the mills in the near future.

I. W. Keerl, a local banker, has purchased a half section of land lying north of Mason City, Iowa, from the Iowa Portland Cement Co., of Des Moines, Iowa, for \$35,000. It is stated that the purchase was made in the interest of a cement manufacturer who is considering the erection of a plant at Mason City.

Rockland, Me.—In another year the New England Portland Cement Co. will have a cement manufacturing plant under construction in the city of Rockland and probably in operation before the end of the year 1910. The bulk of the properties which it was necessary to acquire have been secured.

Fred B. Lane of Little Rock, Ark., and associates have purchased the White Cliffs Portland Cement Companies property and will form a new company. Capital \$3,000,000. The old plant is to be reconstructed and enlarged to a daily output of 3,000 barrels.

Superior business men are greatly interested in the surveys of the Nebraska Portland Cement company of Superior, Nebr., which, according to the statement of President McLaughlin of that company, will result in the establishment of a \$1,000,000 factory to work the cement bluffs near here.

The Commercial Club of Gilmore City, Pocahontas Co., Iowa, claims to have located a high grade limestone rock suitable for the manufacture of Portland cement. The club proposes to organize a company to work the deposit.

The Plano Concrete Co., Plano, Ill., has been incorporated with a capital stock of \$2,500 by F. W. Dunn, W. C. Thompson, I. L. Smith, and a number of others, for the purpose of doing a general concrete block manufacturing business.

THE NEW GIANT GRIFFIN MILL.

The great development of the Portland Cement Industry in recent years has resulted in the construction of immense works, which naturally call for their machinery to be of larger units. In order to meet this demand the Bradley Pulverizer Co., of Boston, Mass., have designed and constructed the GIANT GRIFFIN MILL. It employs the same principle of grinding, and is built on the same general lines as the 30 inch and 36 inch mills, but in it they have embodied some new and improved details of construction which have been suggested by many years of experience in operating the lighter mills. The base alone of this mill weighs about 7 tons, while the weight of the complete mill is over 26,000 pounds. The frame of the mill is of angle iron, thoroughly riveted and bolted together, making a much more satisfactory frame than either the solid cast-iron or the composite frames which they have heretofore used on the smaller mills.

The giant mill shows a marked increase in efficiency, both as to power required to operate it, and in the fineness of the product obtained. It has been fully tested on Portland Cement Clinker, and they have demonstrated that on this material it is a great success. It will take the clinker from 1½ inch diameter, or practically as it comes from the kilns, and give a finished product of which from 85 to 87% will pass the 200 mesh sieve, with no auxiliary apparatus and with a minimum expenditure of power.

It is also well adapted for grinding limestone, coal, and all other hard and refractory materials.

One of these mills has been operating since last May in mill "F" of the Lehigh Portland Cement Company at Ormrod, Pa.

REDUCED RATES TO CHICAGO ON ACCOUNT OF THE THIRD ANNUAL CEMENT SHOW.

We have pleasure in announcing that the Central Passenger Association, which covers in a general way the territory between Chicago and Peoria, Ill., and Pittsburg, Pa., have granted a reduced rate of a fare and one-half. Under this plan tickets to Chicago with certificates may be purchased on any day between February 16-25, inclusive. The certificates will be validated at the Coliseum promptly upon presentation by the holder and will entitle the holder to purchase a return ticket at one-half fare. This year it will not be necessary for one thousand to take advantage of the reduced rate to make it operative; every one who secures a certificate will be guaranteed a half fare on the return trip.

The Trunk Line Association, comprising the railroads operating in New York, Pennsylvania, New Jersey, Delaware, Maryland, Northern and Western Virginia have made a similar reduction the dates of sale being from February 15 to February 23, inclusive.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.

The Northwestern Cement Products Association have decided to abandon their proposed Cement Show and Convention in St. Paul, and will meet in Chicago on February 18, 19 and 21, during the Third Annual Cement Show. This decision on the part of the Northwestern Cement Products Association will mean an

additional large attendance from the Northwestern territory.

SOME CHARACTERISTICS OF CEMENT BRICK.

Although cement brick (or concrete brick) construction is still in its experimental stage enough is known to demonstrate that under favorable conditions it may be a strong competitor of clay brick in both price and appearance.

The extensive use of cement brick by the Plymouth Cordage Co., Plymouth, Mass., has demonstrated several valuable facts. For the construction of their new mill having an aggregate wall length of nearly one-fifth of a mile, almost two and one-half million cement bricks were made upon the ground.

The mixture used in the major part of the work was 3 parts sand to 1 part cement. A few bricks were made of 4 parts sand to 1 cement, for lightly loaded walls. The brick used on the outside of the buildings

Brick	Weight				
	Dry		Saturated		Absorption
	lbs.	oz.	lbs.	oz.	oz.
Face	5	8½	5	10	1½
Common inside	5	8	5	11	3
Facing material	5	9½	5	10	½
Hard burned body clay brick.	4	11	5	7	12

*Brick made entirely of the material used for facing the outside brick.

had a facing (⅛-in| thick after compression) of 2 parts fine sand and 1 part cement, with the addition of 2% waterproofing (by weight) to the cement. Enough water was used to make a mortar of such consistency that it would hold its shape under compression, without flushing water to the surface so as to cause the mortar to stick to the plates. No definite percentage can be given as to the amount of water, as that is governed largely by temperature and atmospheric conditions, but the average amount was about 8%.

Age, days	1st Crack, lbs.	Ultimate strength, lbs.	Per sq. in. lbs.
56	87,100	87,100	2,730
120	100,900	108,650	3,400
239	128,500	132,650	4,145
56	69,750	71,200	2,215
92	95,000	99,100	3,080
120	119,700	119,700	3,735
239	129,000	134,100	4,095
275	162,100	164,600	5,160
56	74,150	76,500	2,390
120	89,050	91,450	2,810
239	119,500	126,400	3,905
56	72,150	72,150	2,240
120	80,700	86,650	2,675
239	110,000	119,950	3,710
...	101,000	150,000	4,770
...	94,000	162,000	5,470

Care in curing the brick (that is, constant wetting), will overcome to a large degree any minor weakness which is theoretically developed by a "dry mix."

To the uninitiated, the small quantity of water used would seem likely to produce a porous brick having a strong attraction for water, with damp buildings as the result of their use. As a matter of fact, these bricks do not absorb water to any great extent. Bricks 30 days old, carefully dried and then submerged in water for 16 hours, showed the results given in Table No. 1.

Table No. 2 shows the results of tests made under the direction of the Ordinance Department of the U. S. Army at the Government Arsenal in Watertown, Mass. The figures are averages unless otherwise noted.

In the tests, some peculiar phenomena were noticed. The best test on a 3 to 1 brick shows 5,460 lbs. per sq. in. The best on a hard burned "body" clay brick showed 5,470 lbs. per sq. in. The average on the clay brick was 5,120 lbs., or slightly less than that for the average cement brick at nine months.

Two bricks made at the same time, from the same stock, show varying results. For instance, two bricks (3 to 1) 275 days old; first crack at 155,200 lbs. and ultimate strength 155,200 lbs.; first crack at 169,000 lbs. and ultimate strength 174,000 lbs. Compare that with the clay bricks; first crack at 94,000 lbs., and ultimate strength 162,000 lbs.; first crack at 101,000 lbs., and ultimate strength 150,000 lbs. Average results show the first crack to be at 0.974% of the ultimate strength for 3 to 1 cement brick, 0.96% for 4 to 1 brick, and 0.943% for 5 to 1 cement brick; and 0.625% for clay brick. The lowest percentage shown in any cement brick was 0.876%.

Six kinds of cement brick were made and used: (1) Common brick, output 13,500 to 14,000 per day; (2) face brick, 9,400 to 9,800 per day; (3) 2-in. radius brick for inside jambs, 8,400 to 8,800 per day; (4) outside corner brick (face and one end waterproofed), 8,000 to 8,400 per day; (5) headers, with one end faced, for arches and header courses, 9,000 to 9,400 per day; (6) white brick (faced with white cement for interior of the engine room), output the same as for the face brick.

REINFORCED CONCRETE PIPE.

San Diego, Calif.—Much interest is being manifested by local cement contractors and others in the construction of the Switzer creek conduit from the south line of the 1,400-acre city park to the bay. The pipe being used on the conduit work is the largest reinforced concrete pipe ever installed on a job of any consequence in California. It is 5 ft. in diameter on the interior and measures 6 ft. across on the outside, the walls being 6 ins. thick.

It is being built for the city by Charles H. Julian, who secured the contract for \$60,576.

The method of making the huge pipe is a feature of the undertaking which has attracted attention. The pipe is made in 3-ft. lengths on the ground near the trench where it is installed.

The sections are cast in collapsible forms. The base of the form is a heavy iron flange, while the sides are made of sheet steel and fastened together in four sections on both the interior and exterior sides. Four bands of steel and four steel rods are wired in the form, making a net work of reinforcing for each section of pipe.

The concrete is mixed in a Cube concrete mixer, driven by a gasoline engine. From this machine gangs of men are kept busy wheeling the concrete to the various forms in which the pipe is cast. An average of about thirty 3-ft. sections of the pipe are cast daily. The pipe is allowed to rest in the molds for twenty-four hours. After the molds are removed each section is wrapped tightly with burlap and allowed to stand for six days, being moistened daily with water. The sections are then turned on edge, but the contractors are required to wait at least fourteen days from the time the pipe is cast before it can be placed in the ditch. The pipe is being made under the direction of E. T. Flaherty. Charles A. Nagle, who is acting as inspector for the city, says the contractors are turning out a material that is fully equal to or better than the requirements of the job specifications.

BAMBOO CONCRETE REINFORCEMENT.

The construction of houses and walls of concrete is an industry peculiar to Swatow, China, says a Consular Report. The work was instituted several hundred years ago, and the absence of any buildings or walls constructed of brick is conclusive proof of its stability and lasting qualities.

Very small pebbles or shale sand, and lime are the ingredients of which the material is made. The mixture, after being thoroughly incorporated, is slightly moistened, and then pounded in a rough wooden mould which is elevated in a runway supported by firmly set poles, and in spite of the crude methods employed, a height of 60 feet can be easily reached. When the walls have been constructed, all supports are removed and the concrete is for some days exposed to the air. To this exposure is its characteristic solidity solely attributed. The walls vary from 12 to 16 inches in thickness, and the cost of construction is considerably less than brickwork. The thickness of the walls gives absolute guarantee of fireproof qualities. Storehouses and buildings constructed of this material many years ago are conclusive proof of its strength and durability. No single instance has been known of the accidental collapsing of such concrete-built walls.

In some instances split bamboo poles have been used to reinforce the material, the wood preventing cracks from appearing and adding to the strength. Bamboo embedded in the concrete in this manner does not rot, and it seems somewhat singular that the practice is not more general. Steel or iron reinforcing, owing to the added expense, is never used.



LINK-BELT COMPANY
CONVEYING MACHINERY

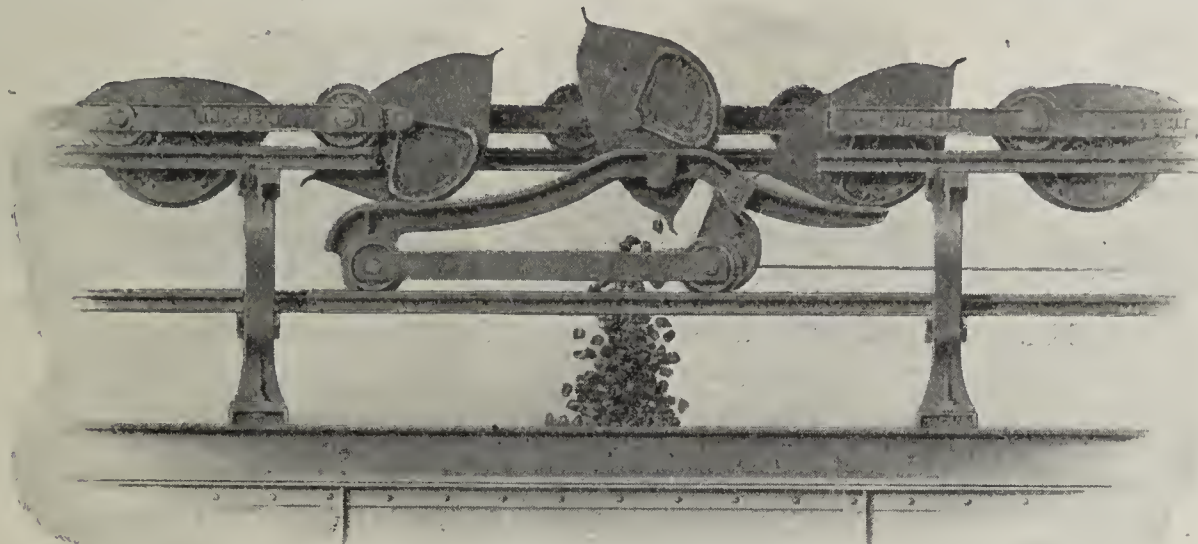
PHILADELPHIA

CHICAGO

INDIANAPOLIS

PECK CARRIER

The Standard Machine for Handling
Cement, Crushed Rock, Hot and Cold Clinker, Coal, Etc.



Full particulars in book now in preparation—copies will be sent to those interested. To make sure, please send YOUR name.

LINK-BELT COMPANY

PHILADELPHIA

CHICAGO

INDIANAPOLIS

NEW YORK:
299 Broadway

PITTSBURGH:
1501 Park Building

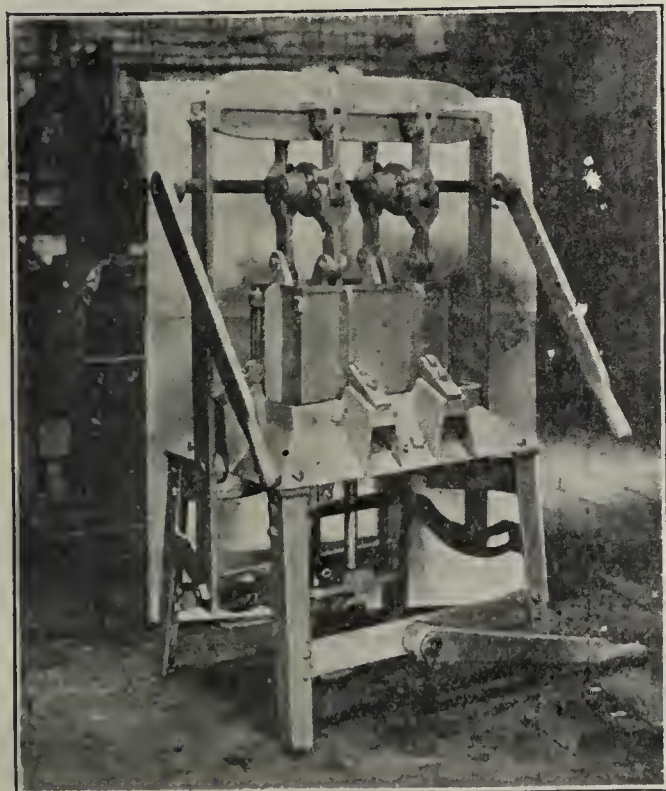
ST. LOUIS:
Missouri Trust Building

SEATTLE:
440 New York Block

DENVER:
Lindrooth, Shubart & Co.

NEW ORLEANS:
Wilmot Machinery Co.

The Birn Rapid Process Concrete Block Press



The only concrete block machine built to apply and withstand enough pressure to make good, compact angle blocks. The material is so distributed as to make all parts powerful and capable of withstanding the highest pressure. This pressure is applied by means of

Toggle Joints

—the best and most positive means of producing the desired force. The plates are interchangeable. These plates are so firmly set when the machine is in operation that it is impossible to get out of alignment, but when not in operation they can be readily lifted with ease and replaced.

Investigate this machine before buying. Ask for further information, and convince yourself that it is the machine you have been looking for.

Joliet Concrete Machinery Co.

JOLIET, ILL.

GLIDDEN

GLIDDEN'S LIQUID CEMENT

Uniforms the color of Concrete-Cement and Plaster surfaces, producing a waterproof result.

Made in Sandstone finish and several shades along the lines of Colonial and Pompeian Buffs.

Inexpensive and easily applied.

Samples and full information gratis upon request.

A product of The Glidden Varnish Company, exclusively.

The Glidden Varnish Company, CLEVELAND, OHIO

GLIDDEN



JEFFREY Type "B" Hammer Pulverizer

Is the most successful and complete machine on the market for reducing limestone, gypsum, shale, fireclay, phosphate rock, run of mine coal, etc.

Send for Catalog Aa 31.

We also build Elevating and Conveying Systems for all purposes, Excavating and Screening Plants, Drills, Revolving and Shaking Screens, etc.

The Jeffrey Mfg. Company
Columbus, Ohio

NEWYORK
BOSTON
PITTSBURG

CHICAGO
ST. LOUIS
DENVER
BUFFALO

KNOXVILLE TENN.
CHARLESTON, W. VA.
MONTREAL, CAN



LINK-BELT COMPANY
CONVEYING MACHINERY

PHIDADELPHIA

INDIANAPOLIS

CHICAGO



McCaslin Conveyor over Storage Bin Handling Hot Clinker

The McCaslin Conveyor

Acknowledged by Competent Engineers as the best Conveyor in the world for handling hot clinker, stone, etc., in **CEMENT PLANTS.**

Low Cost of Maintenance Absence of Shut Downs
Maximum of Efficiency

Manufactured solely by

Mead, Morrison Mfg. Co.

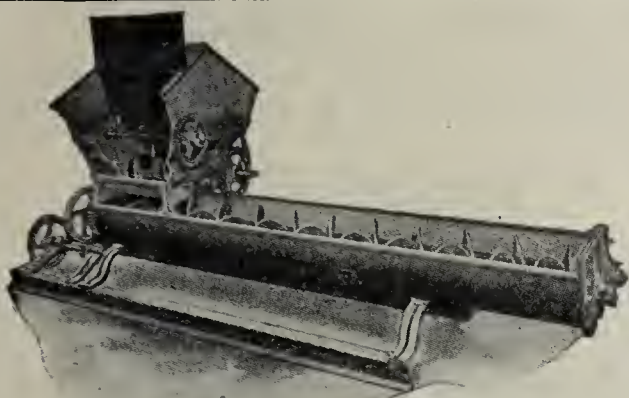
BOSTON

NEW YORK

CHICAGO

Catalog on Request

Send Us Your Specifications for an Estimate



MIRACLE CONTINUOUS MIXER

This continuous mixer preserves the proportions of cement and aggregate as accurately as a batch mixer, and it mixes the constituents perfectly. It will turn out in absolutely prime condition a mix of 50 cubic yards in a day of 10 hours, running only 40 revolutions per minute, and it can be speeded up so as to handle satisfactorily over 75 cubic yards per day.

The Miracle Continuous Mixer is operated by a 3 H. P. self-contained gasoline engine, which under the severest tests of actual use has been found amply effective. The engine is guaranteed. Mixers may be bought with or without power, and either on skids or on trucks, as preferred. Full description of the Miracle Continuous in a new booklet, just out. Send for it.

Miracle Pressed Stone Co.

Minneapolis, Minnesota

Location for Cement Plant

Extensive Deposits of Raw Material. Proximity to Large and Growing Markets. Low-Priced Fuel Supply.



THERE ARE several desirable locations for Portland Cement Plants along the Santa Fe, where the advantages enumerated are to be found. If you are interested you can secure full and detailed information by addressing this office.

The SANTA FE is glad at all times to co-operate with those seeking locations or desirous of investigating conditions in territory tributary to its line. Correspondence from interested manufacturers is invited.

WESLEY MERRITT, Industrial Commissioner A., T. & S. F. Ry.
1122 Railway Exchange Building

CHICAGO, ILL.

Face Your Blocks

Make Them White

Do You
Use

WHITE SAND

Leading contractors specify our pure White, Washed and Screened Silica Sand for fine work in ornamental stone, block facing, porch work, ornamental lawn fixtures, vases, etc.

This sand is shipped both DRY and DAMP.

Prices and Samples on request.

BALLOU'S WHITE SAND COMPANY
MILLINGTON, ILLINOIS

"Laying Concrete Has Begun on the Miraflores Lock"

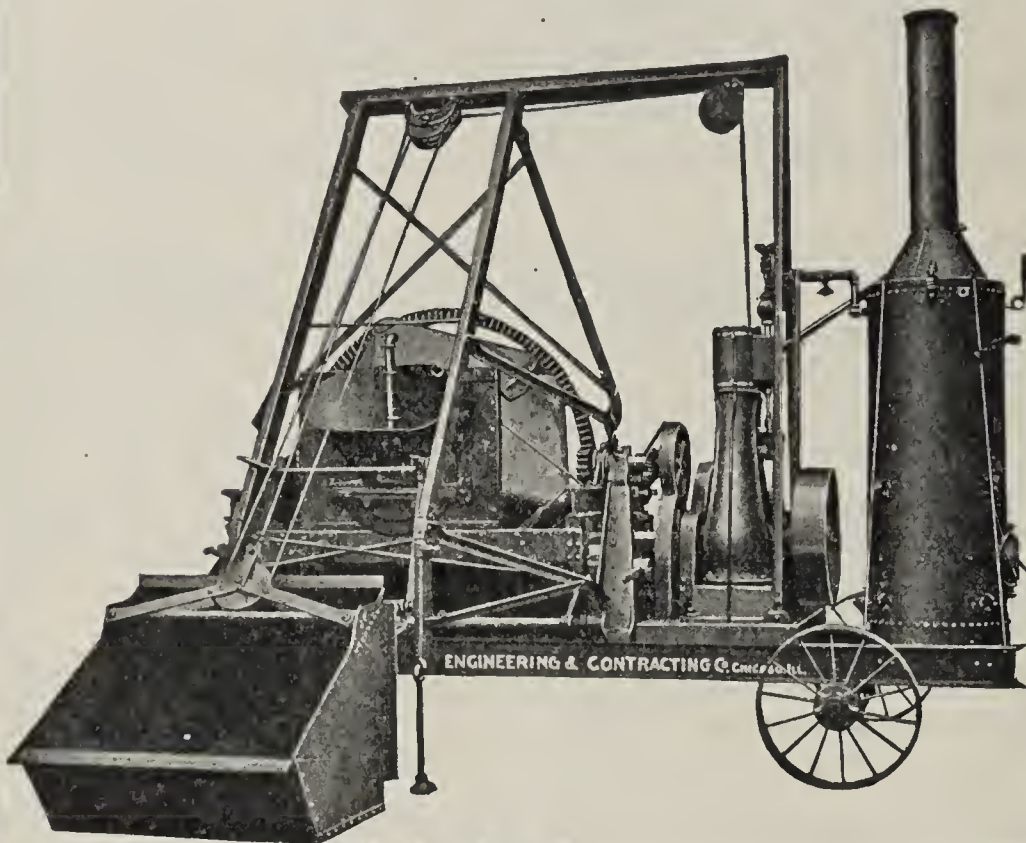
The above quotation from the "Canal Record" means that the large two cubic yard CHICAGO IMPROVED CUBE MIXERS shipped to Panama some months ago are getting to work on the greatest concrete locks in the world.

The Chicago Improved Cube Mixer was adopted by the engineers of the Panama Canal after practical test on preliminary construction alongside all other leading makes of concrete mixers.

This fact means a great deal more than that Chicago Improved Cube Mixer has won a commercial victory over its competitors. The locks of the Panama Canal are to be of unprecedented size. Upon their perfect construction rests not only the successful operation of the canal, but the reputation of the engineers who decided on a lock canal in face of strong opposition arguing the danger of locks. No chance is being taken that can possibly be avoided in building these locks. No factor which will contribute to their perfection is being neglected.

The greatest of all the factors working toward success is perfect concrete, and the selection of materials and machines for making concrete has been guarded from error in every possible way. That the Chicago Improved Cube Mixer was selected stamps it as the superior of all other concrete mixers.

Write for catalogue No 7, describing
The World's Greatest Mixer for the World's Greatest Canal.



**MUNICIPAL
ENGINEERING & CONTRACTING CO.**

RAILWAY EXCHANGE BUILDING, CHICAGO

New York Agents: Motley, Green & Co., 68 Broad Street
New England Agents: Dyar Supply Co., Boston, Mass.

Pacific Coast Agencies: Lansing Wheelbarrow Co., San Francisco, Cal.; F. T. Crowe & Co., Seattle, Spokane, Tacoma, Portland.

Colonial Trust & Savings Bank

A BANK FOR THE PEOPLE

Pays 3% on Savings Accounts

Capital and Surplus, \$1,106,620

YOUR ACCOUNT INVITED

205 La Salle Street, - - - - - Chicago, Ill

Inland Steel Co.
Steel Makers
CHICAGO
**CONCRETE
REINFORCING BARS**

Open Hearth—all grades.
Bessemer—high elastic limit.
Plain and Twisted.

(Capacity, 500 tons
per day)

Hess Furnaces



No. 45
**"Leader" Hess
Steel Furnace**
Price \$49.00

Delivered East of Omaha and
North of Ohio River
Pipes and Registers Extra

for the past 7 years, have been sent to customers in every state in the Union, freight prepaid,

On Approval

and the money held back till sixty winter days of actual trial have proved that all our claims for superiority have been fulfilled.

Isn't this worth looking into? Could we offer such liberal terms if we didn't know that the Hess Furnace excels in service, simplicity, efficiency, economy?

All we ask of you, if you need a furnace, is to investigate—to put your name on a postal card, mail to us and ask us for our booklet "Modern Furnace Heating." This booklet is an authority on furnace heating, and copies have been requested by many colleges, libraries, etc., for reference in engineering and mechanical courses. It instructs fully in the principles and practice of furnace heating, and should be in the hands of every builder and house owner. It is free on request.

**In Buying Direct
From Our Factory You Pay Only
One Profit—A Small, Factory Profit.**

Our prices are not inflated with the usual cost for salesmen, branch stores, agents' and dealers' profits. The factory profit only, satisfies us, and you will be surprised at how much we can save you.

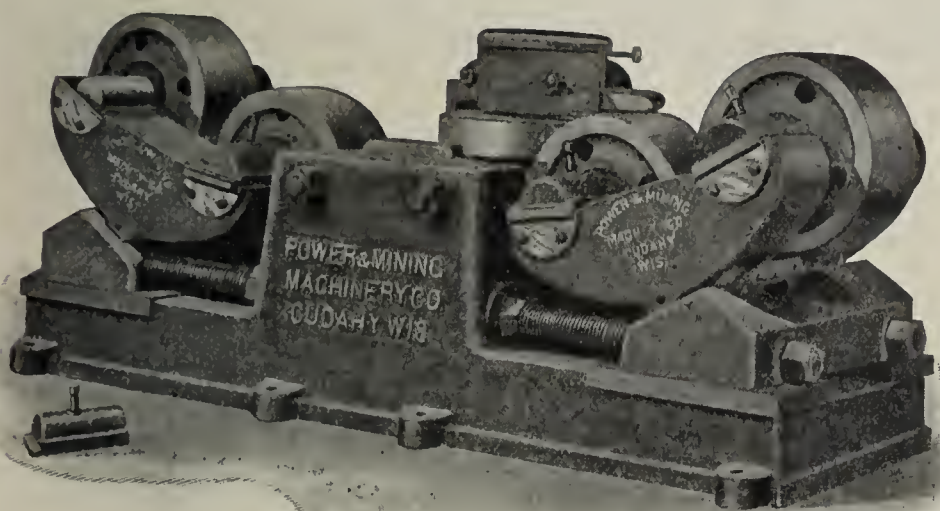
Special Heating Plan Free Before You Order

Let us have our experts prepare a special plan for heating your building. It will cost you nothing, and put you under no obligation to buy of us. Our thirty-six years of experience in designing heating equipments makes this free plan valuable to you.

Ask us more about it. A postal card today will serve the purpose.

Hess Warming & Ventilating Co.
919 Tacoma Bld., Chicago.

Cement Mill Machinery



We illustrate our standard kiln base as an example of the high grade work put into all our machinery for the manufacture of Portland Cement. If you are interested in cement making you should know of the best machinery for the purpose.

Write for Catalog 17,
Cement Making Machinery

ROTARY KILN BASE

McCully Crushers, Crushing Rolls, Rotary Dryers, Kilns, Coolers, Tube Mills, Heavy Conveyors.



CHICAGO

NEW YORK

EL PASO, City National Bank Bldg.

CUDAHY, WIS.

SALT LAKE CITY

MEXICO CITY

Sheldon Bldg., SAN FRANCISCO

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

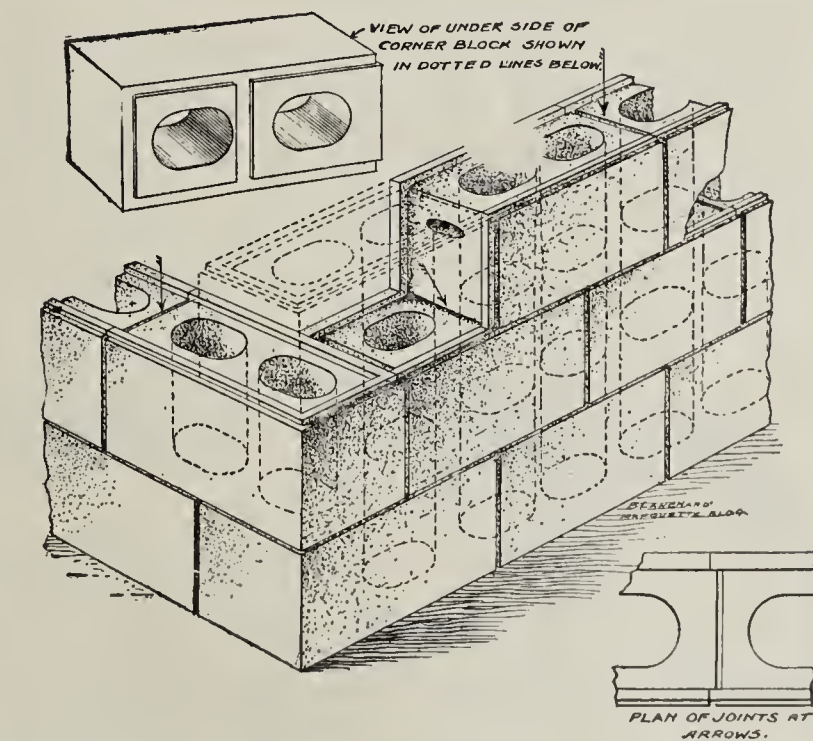
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting
Face-Down Machine by the Wet Process

The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and



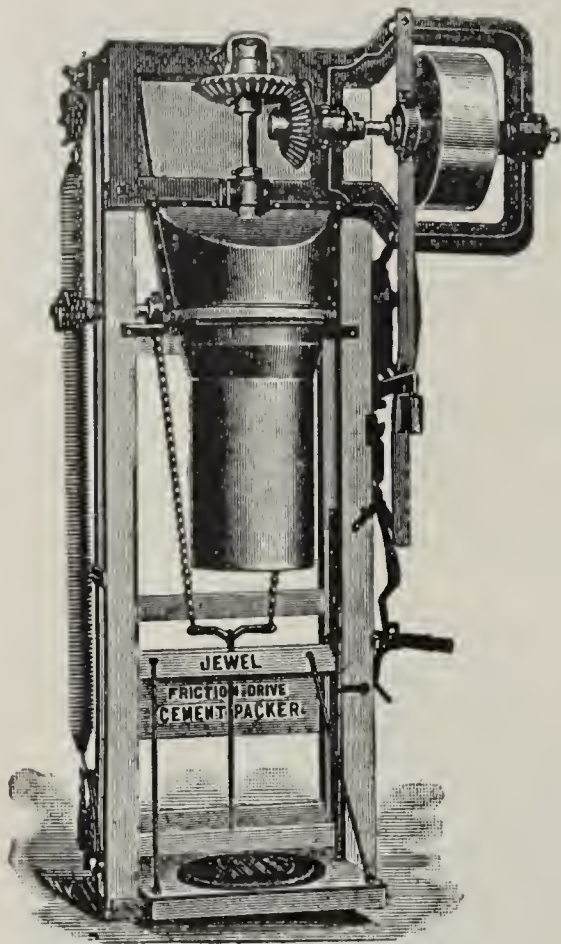
agents wanted in all states and foreign countries.

DIAMOND CONCRETE MACHINERY COMPANY

Chamber of Commerce Building,

Chicago, Illinois

There is more Cement being packed by the "S. HOWES" Company's Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and sacks.

The "JEWEL" FRICTION driven cement Packer, specially constructed for rapidly packing sacks.

Both machines are equipped with friction pulleys, heavy iron frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company
SILVER CREEK, N. Y.

The Hoosier Concrete Tile Machine

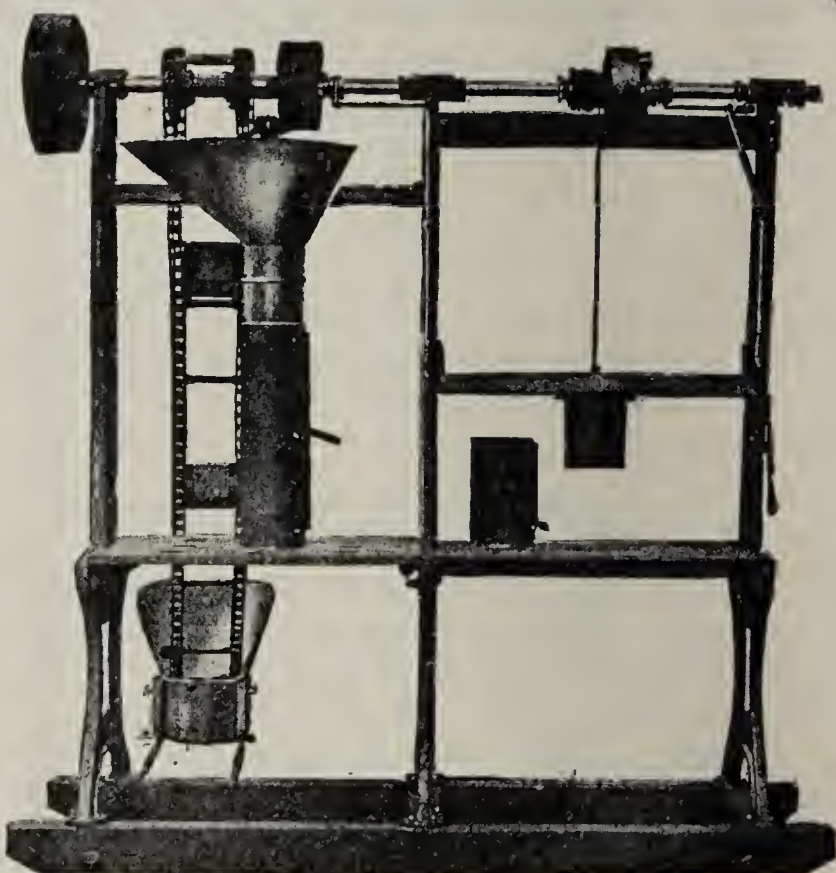
THE SUCCESS of this tile machine lies in the principle of construction—a principle that is radically different from any other tile machine. It is more simple and every part is well made and durable.

LOOK

It is without a doubt the only machine that works coarse, wet concrete.

Before you buy, address

HOOSIER CONCRETE TILE MACHINERY CO.
R. Z. SNELL, General Manager, MERCHANTS NATIONAL BANK BUILDING
SOUTH BEND, INDIANA



Why Concrete Needs to be Waterproofed

Ordinary concrete lacks stability. It absorbs moisture. This moisture freezes and expands. Then it thaws. This freezing and thawing causes the concrete to disintegrate, to crack and crumble.

For the better building purposes concrete must be free from dampness. It must not absorb moisture. Hence it must be waterproofed.

Aquabar

will thoroughly and permanently waterproof concrete. It affords positive protection against any destructive effects of moisture. It makes concrete absolutely impervious to dampness.

Aquabar's simplicity enables unskilled labor to successfully handle it. One two-gallon can is dissolved into each barrel of water used in mixing the concrete. As the water comes in contact with every particle—so does the Aquabar. As the concrete sets, the Aquabar crystallizes, sealing completely every void between the sand and cement. Thus an absolutely waterproofed construction is formed.

Aquabar will waterproof any concrete construction—walls basements, floors or stucco coatings.

Our engineers will give your case their personal attention, without charge, if you will write us the full particulars about your concrete construction. Also write for our two free booklets and learn all about waterproofing.

Girvan-Nachod Co.

General Sales Agents

1228 Locust Street, Philadelphia, Pa.

34 W. 33d ST., NEW YORK CITY, N. Y. Tel. Madison Square 5296.

AGENTS IN ALL LARGE CITIES.

Note:—We also manufacture Aquabar Wash, which is wonderfully effective in weatherproofing old concrete walls.



Universal is Uniform

Uniform in soundness—
Uniform in strength—
Uniform in fineness—
Uniform in color—
Uniform in specific gravity—
Uniform in setting qualities—
Uniformity means superiority.

Use Universal—it produces uniformly excellent results.

Universal
Portland Cement Co.
Chicago — Pittsburg



DEXTER Portland Cement
THE NEW STANDARD

Sole Agents **SAMUEL H. FRENCH & CO.** Philadelphia

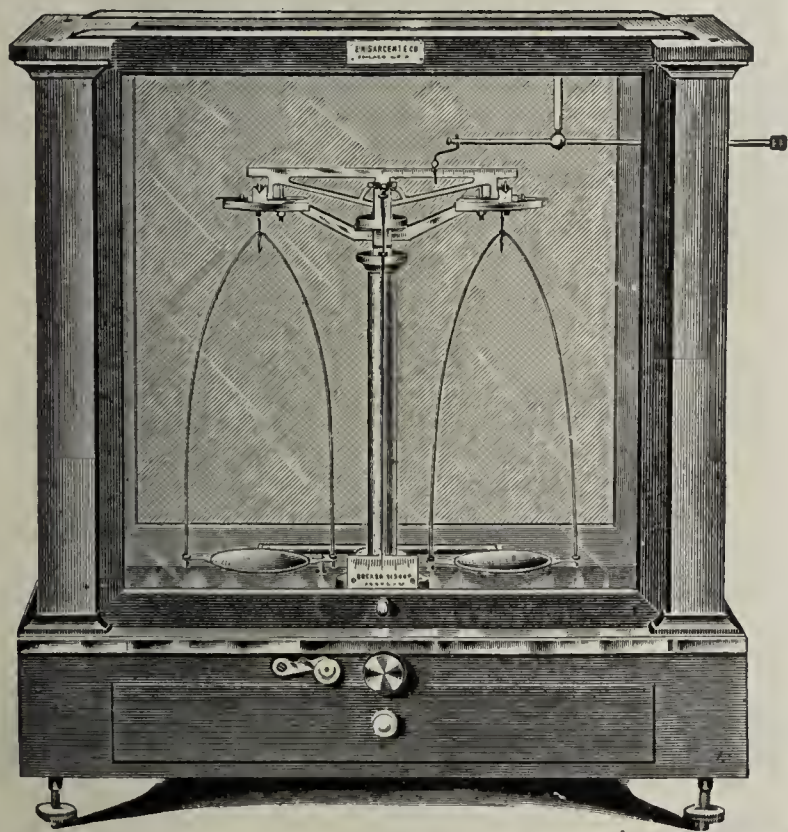


HAVE YOU AN IDEA?

If so write for our books: "Why Patents Pay," "What to Invent," "100 Mechanical Movements" and a Treatise on Perpetual Motion—50 illustrations. All mailed free.

F.G. DIETERICH & CO. Patent Lawyers and Experts

801 Ouray Block WASHINGTON, D. C.



E. H. SARGENT & CO.

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN
CHEMISTS SUPPLIES

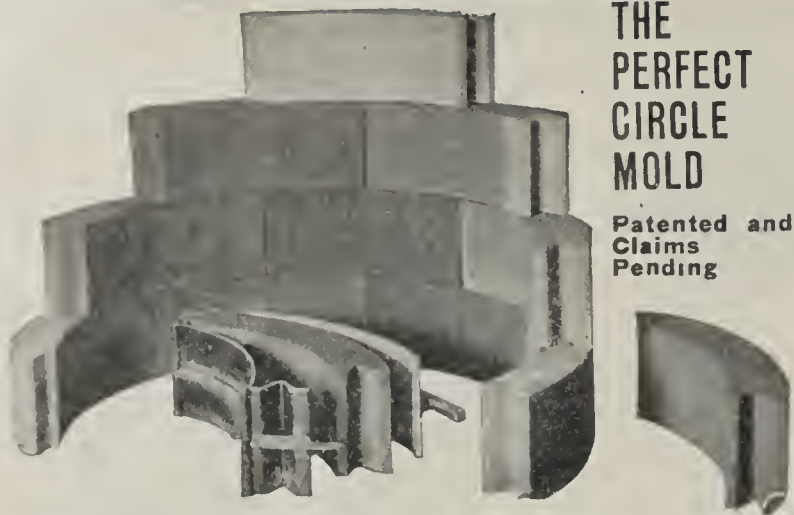
Of high grade only.

We call particular attention to our Cement Mould, Vicat Indenting Apparatus, as improved by us, Gilmore's Needles, Jackson's specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

CHICAGO



**THE
PERFECT
CIRCLE
MOLD**
Patented and
Claims
Pending

The Perfect Mold was invented by C. S. Wert, of Kendallville, Ind. Manufactured in any sizes. In ordering give the Inside Diameter. The three most in use are No. 1, with diameter of its circumference 3 ft; No. 2, diameter of its circumference, 5 ft. No. 3, diameter of its circumference, 7 ft. Also 10, 12 and 14 ft. Diameters used for silos.

CONSTRUCTION.

The circle mold is built of No. 10 gauge sheet steel, reinforced with T-Iron. The molds are 8-in. high, 4-in. thick, making them strong and durable. These curbing blocks can be made on the ground or floor, or can be made on wooden pallets. Those in the concrete manufacturing business cannot afford to do without one of these molds, as all up-to-date concrete plants are equipping themselves with one or more of my curbing molds, for they all see at a glance their importance and utility, simplicity in operation, durable construction, and lasting qualities in products, as well as completion of a well equipped plant, showing the ability of a man's occupation or business. These molds are no experiment but an up-to-date invention, practicable, durable, simple and useful, and are only appreciated by those who have them in store. Selling at a price within reach of all. The output of these molds is greater than can be produced on any other mold, thus reducing the labor and cost of making the products, and also increasing the Profits.

These molds will enable you to make better products than can be produced on any other machine or model and sell for more money. Just what an up-to-date concrete constructor needs is an up-to-date plant. In a class by themselves, possessing many advantages over all others. Absolutely the best and cheapest molds ever offered to the public.

Do you know that 99 concrete cement men out of every 100, who are successful in their business, purchase the best molds in the land, and they are found and manufactured by C. S. Wert, who is the inventor, manufacturer and sole owner. Write for prices. Address, C. S. WERT, 602 N. Main Street, Kendallville, Indiana.

2c Will Mail This Ready-Made Letter

Sign your name, check off what you are interested in, and mail to-day:

Miracle Pressed Stone Co.,
Dept. L., Minneapolis, Minn.

GENTLEMEN:

Please send me FREE your new 1910 CATALOGUE showing new features; Collapsible Steel Forms for Culvert, Conduit and Sewer Work; New Magic Tamper; New Revolving Sand Screen; Miracle Positive Feed Continuous Mixer; New Ornamental Molds and other new developments. Also include your Latest Discount Sheet. I am especially interested in (check off below.)

Double Air Space Block Machines.....	_____
Side Face Single Space Block Machines	_____
Face Down Single Space Block Machines	_____
Special Plates for Ornamental Work...	_____
Brick Machines (3 styles).....	_____
Cement Pipe Molds.....	_____
Bell Attachments for Above.....	_____
Bevel and Tongue for Above.....	_____
Batch Mixers.....	_____
Continuous Mixer (Special Booklet)...	_____
Collapsible Steel Forms.....	_____

Name_____

P. O. Address_____



A New Catalog For You

This new illustrated sixty-four page catalog has just been received from the press and will be mailed to you free upon receipt of your request.

It is a book compiled after many years of experience in the manufacture and use of concrete machinery and equipment, and embodies many fine-toned illustrations of the highest class concrete machinery in existence. It also contains much useful information for the buyer and will be found a handy reference book.

If you are in the market for anything in the line of concrete machinery or equipment you should receive this catalog before purchasing. The merits of the machines and the clear illustrations are sure to please and interest you. Don't put it off—send us your name right now. Tell us just what you are interested in most and receive this catalog with complete information and prices.

The Cement Tile Machinery Co.

"EVERYTHING IN CONCRETE MACHINERY."

1624 WEST RATH STREET

WATERLOO

IOWA



The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa.

WANT COLUMNS.

Advertisements in this column are inserted at the rate of two dollars per inch per issue—and no advertisement will be taken less than two dollars and must be paid strictly in advance.

PURCHASING AGENT.

Desires employment—fully qualified—seven years experience with largest cement company—highest class references. Address, B, Care Cement & Engineering News, Chicago, Ill.

WANTED.

Position as chemist by young man having college education and experience in dry process mills. References furnished. Address W. P., care Cement & Eng. News.

Cement superintendent open for position. Mechanical engineer, 12 years' experience designing, building and operating. Address H. R., care Cement & Eng. News.

POSITION WANTED.

By young man 38 years old. Ten years' experience as Chemist, Assistant Superintendent and Superintendent in the manufacture of Portland Cement by both dry and wet process. At present employed, but desires change of location. Address, W. H. Simmons, care Cement & Engineering News.

WANTED.

Position as sales manager or assistant sales manager for cement plant. Have six years experience. At present employed, but desire change. Address G. D., care Cement and Engineering News.

WANTED.

Two first-class, experienced traveling Portland cement salesmen for territory west of the Mississippi river. No beginners or parties handling other lines need reply. Give references, also salary expected. Address, Salesman, care Cement & Eng. News.

WANTED.

First-class, second hand Air Compressor with cross compound steam and air cylinders and Corliss gears, size: 12-22-18 $\frac{1}{4}$ -11 $\frac{1}{4}$ x36. Address W. F., care Cement & Eng. News.

WANTED.

If you are interested in pumps of latest and best styles, send to us for book and catalogue. Pumps of all styles and for all used. The Columbus Steam Pump Works, West Broad street, Columbus, Ohio.



LINK-BELT COMPANY CONVEYING MACHINERY

PHILADELPHIA

CHICAGO

INDIANAPOLIS

Peerless Portland Cement

MANUFACTURED AT UNION
CITY, MICH.

Every Barrel Guaranteed

Fineness, Uniformity of Color
and Sand Carrying Qualities
equal to any Portland Cement Manufactured

FOR SALE

2--100-in. FANS or BLOWERS
1--110-in. " " "

Water Jacketed Bearings—Pulley Drive—Upward Discharge—Made by the American Blower Co., Detroit, Mich. Used only a few weeks. In good condition. Will be sold at a Bargain.

ADDRESS: Peninsular Portland Cement Co.
JACKSON, MICH.

The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker
1½ inches diameter from the kiln
and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

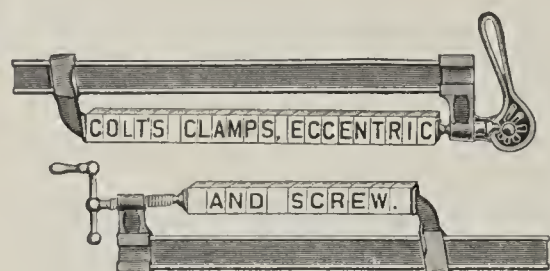
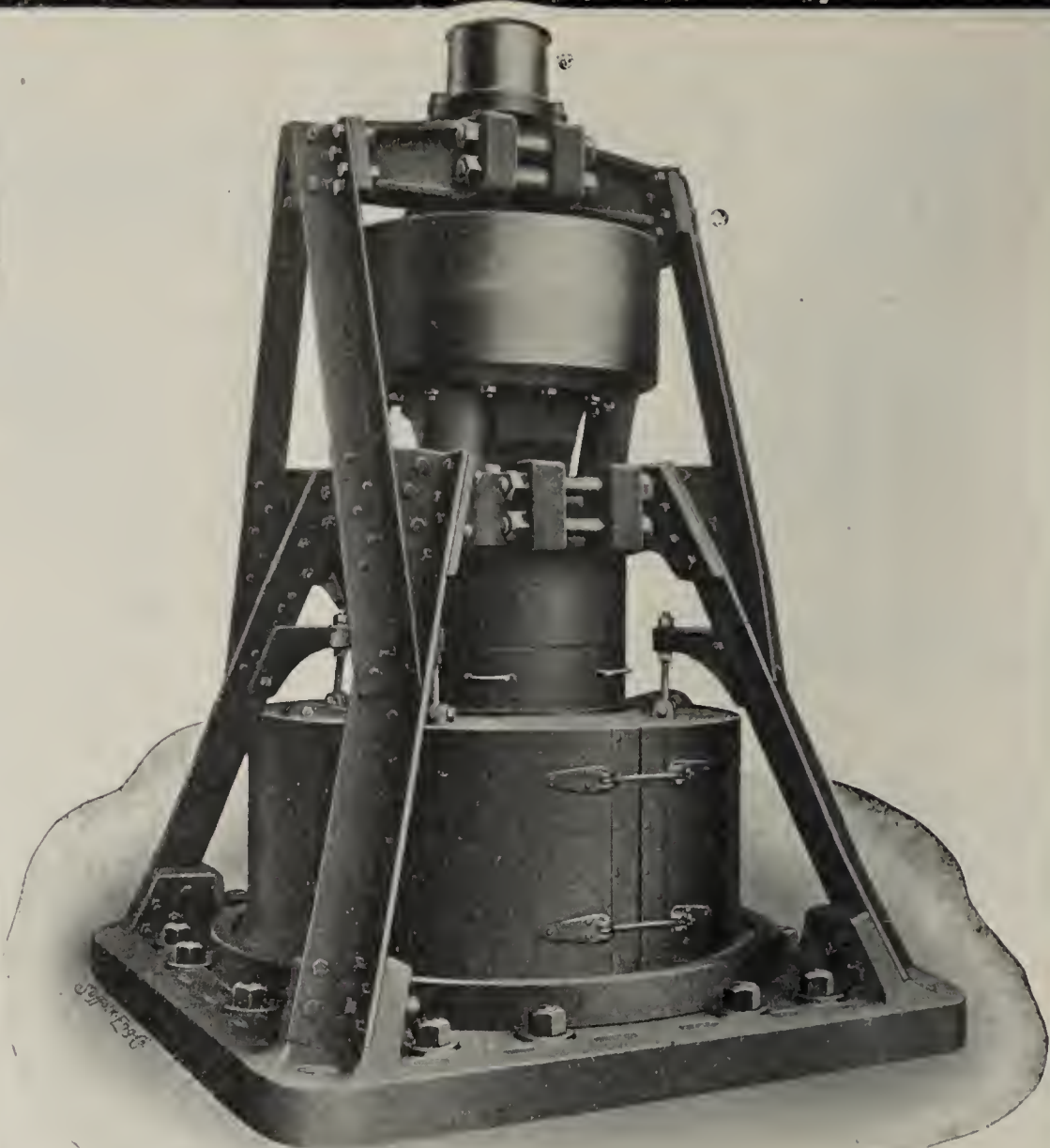
It saves cost in attention.

MANUFACTURED BY

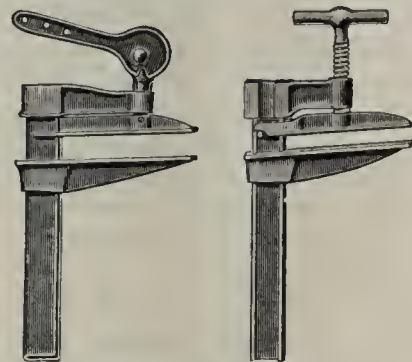
BRADLEY PULVERIZER CO.

37 Walbrook
LONDON, E. C.

92 State St.
BOSTON



Colt's Clamps



Quick Acting. Time Saving. Use them with your Moulds and Curbing

Ask for catalogue No. 156.

BATAVIA CLAMP CO., 101 Center Street
BATAVIA, N. Y.

Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - - 645 No. Sixth St., Terre Haute, Ind.

THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

Design, Construction, Remodeling and Operation
of Portland Cement Plants

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street New York Canadian Express Bldg., Montreal, Can. 1121 The Rookery Chicago 425 Washington St. San Francisco, Cal. Monongahela Bank Bldg. Pittsburgh Syndicate Trust Bldg., St. Louis, Mo. Norfolk House, Cannon St. E. C., London

The Osborn Engineering Co. Civil, Mechanical and Electrical Engineers

OSBORN BUILDING, CLEVELAND, O.

Experts in the Designing of
CEMENT PLANTS.

Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of Cement Machinery

42 NORTH 16TH STREET

:-:

PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

Northrup Bldg., Iola, Kas.

Cement Engineers

Just Out

Architects' and Engineers' Hand Book on
Reinforced Concrete
Construction

ONLY ONE DOLLAR

CEMENT & ENGINEERING NEWS

22 Fifth Avenue, - - Chicago

MEDUSA WATER-PROOF COMPOUND

Makes all concrete watertight

Write for pamphlet describing its use. Do not accept a substitute, as there are many adulterated compounds on the market
It is not a wash, or an experiment



Illustration of Soulard Public Bath House, St. Louis, Mo. Pool, Floors, Steps and Walls surfaced with Medusa Pure White Stainless Portland Cement, containing Medusa Water-proof Compound.



Sandusky Portland Cement Company

Sandusky, Ohio

Write for free Sample of our White Portland Cement

Obtain our prices on Medusa Portland. Annual Capacity, 1,500,000 bbls.

IRON-ORE CEMENT

The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in place of Portland cement for all Marine Construction.

Send for Literature, Etc.

Worm-Cox Company
SOLE AGENTS

Marquette Building, Chicago

LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GROUND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.,
ALLENTOWN, PA.

Western Office:
725 ROCKEFELLER BUILDING,
CLEVELAND, OHIO.

ALPHA PORTLAND CEMENT....

Quality unexcelled The Recognized Standard American Brand Always Uniform
ALPHA PORTLAND CEMENT CO.

Alpha, N. J.
Works: Martins Creek, Pa.
Manheim, W. Va.

Manufacturers of but one grade—strictly straight Portlan
General Office, EASTON, PA.

"VULCANITE" PORTLAND CEMENT

MAIN OFFICE

Land Title Building
PHILADELPHIA

SALES OFFICE

Flat Iron Building
NEW YORK

WM. B. SCAIFE & SONS CO.

221 First Ave., Pittsburg, Pa.

WE-FU-GO

and **SCAIFE**

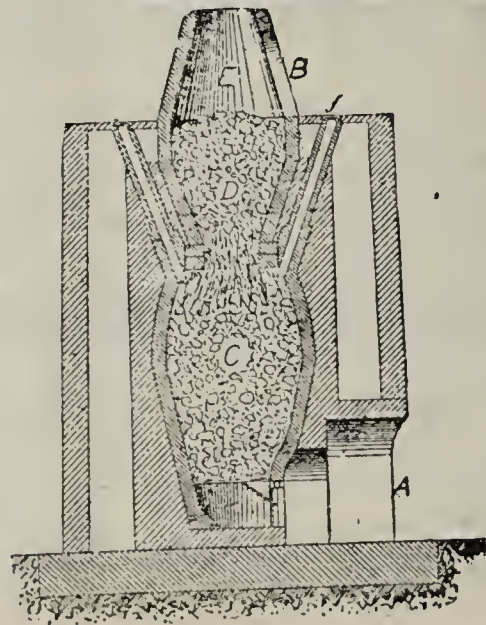
Water Softening, Purifying, and Filtering Systems

— FOR —

BOILER FEED

AND EVERY INDUSTRIAL USE.

Send for Complete Information



The Kiln & Chimney Construction Co.

197 HAVEMEYER STREET
BROOKLYN, N. Y.

We build Kilns for burning Lime and Cement, also

CHIMNEYS

REPAIRING and REMODELING
our SPECIALTY

GOVERNMENT STANDARD OLD DOMINION PORTLAND CEMENT

A Practical Cement for all Uses. Uniform—Strong—Durable. Every Barrel Guaranteed.

MANUFACTURED BY
VIRGINIA PORTLAND CEMENT CO.
FORDWICK, VA.

SOLE SELLING AGENT
Wm. G. Hratranft Cement Co.
Real Estate Trust Bldg.,
Philadelphia

MEACHAM & WRIGHT CO.

Sales Agents
IMPROVED

UTICA HYDRAULIC CEMENT

And Dealers in

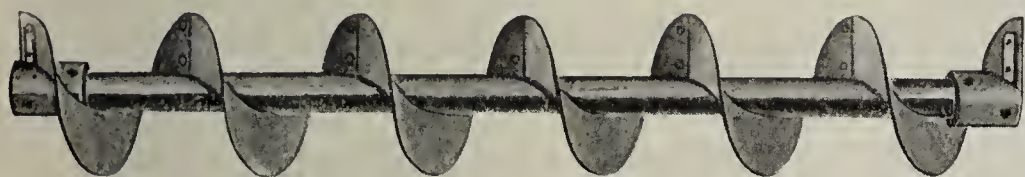
LEHIGH PORTLAND CEMENT

Telephone Main 59 206 La Salle Street, Chicago

F. D. MEACHAM, Pres.
S. P. BLOUNT, Treas.

F. S. WRIGHT, Vice-Pres.
C. M. FOSTER, Secy.

ELEVATING—CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys,
Shafting, Shaft Bearings, Link Belting, Special Chains

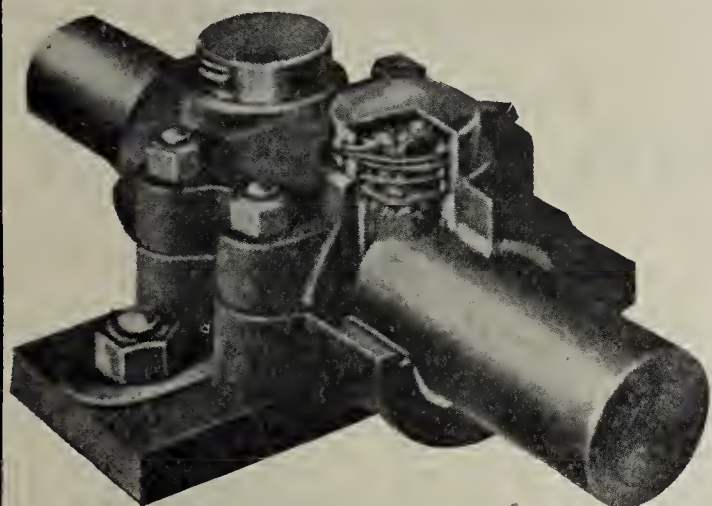


HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES.
Catalog for the asking.

SKILLIN & RICHARDS MFG. CO., CHICAGO

Your Coal Bill



Is something you constantly watch. If you could find an engineer who would save 10% you would pay him a large salary.

Did you ever stop to think that a reduction of friction throughout your plant, would reduce the amount of power necessary, hence a reduction in coal consumption?

You will of course admit that perfect lubrication would greatly reduce friction.

The new VAN DOREN LUBRICATING DEVICE is designed to give PERFECT LUBRICATION, and it DOES WHAT IT IS DESIGNED TO DO.

Your saving on oil, will in less than a year pay the cost of installation.

Your COAL SAVING is YOURS from the start.

Send for Complete Information.

C. J. VAN DOREN CO.,

426 WEST MADISON STREET
CHICAGO

These are Weller-Made

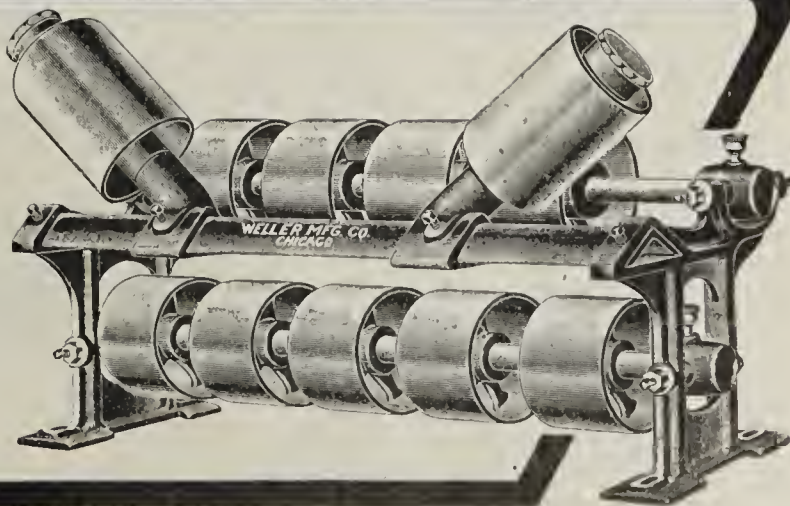
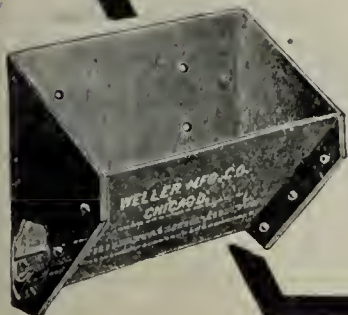
—and that is a guarantee wherein they are well made.

The Standard Combination Throughing Carrier Style B. is not only unique in construction because of its various good features, but it's a real money and worry saver to those upon whom devolves the maintenance of belt conveyors. Our catalog explains the "why and wherefore." You'd do well to write for it to-day.

The Heavy Steel Bucket illustrated is chiefly used in Cement Plants. Its curved inside bottom insures free delivery and is very desirable therefore, for handling certain classes of material. This bucket has supplanted the ones of malleable iron; its use is a proved value.

Write for our No. 19 512-page Catalog, showing complete line of Elevating, Conveying and Power Transmitting machinery. It's to our mutual benefit that you should have it. The catalog tells "why." Write to-day.

WELLER MFG. CO., CHICAGO





The Longest, Strongest and Best Stitched
Canvas Belt in the World

In Use Conveying Rock from the Quarry to the Mills of One
of the Largest Cement Plants in the Southwest.

Best on the market
Uniform in construction
You will like it
Applicable always
Limitless in its
Possibilities under
Hardest conditions
A stitched canvas belt

MANUFACTURED BY

The American Belting Co.,
YOUNGSTOWN, OHIO

Chicago Branch: 161 LAKE STREET

atalogue and Prices Upon Request

AGENTS EVERYWHERE

Ricketson's Mineral Colors

Having long earned, by their great strength, brilliance
and perfect mixing of qualities, the premiere place as a

Coloring for Cement, Mortar, Brick, Stone, Etc.

Red, brown, buff, purple and black--are clean and pure. Twenty years
exposure to weathering has proven their absolute permanence. They
never crack, never run and **THEY NEVER FADE.**

Ricketson's Mineral Paint Works

MILWAUKEE,

WISCONSIN

JUST A REMINDER

ATLAS DRYERS—DRY NEARLY EVERYTHING

THE ATLAS DRYER CO., CLEVELAND, OHIO



German-American Port-
land Cement Works

OWL CEMENT

Illustrated Pamphlet Mailed on Request.

E. L. COX, General Sales Agent,
1527 Marquette Bldg.,

Works: La Salle, Ill. CHICAGO





OFFICES

BIRMINGHAM
BOSTON
BUFFALO
CHICAGO
CINCINNATI
DENVER
DULUTH
HAZLETON
HOUGHTON
HUNTINGTON
JOPLIN
KANSAS CITY
MEMPHIS
MEXICO CITY
NASHVILLE
NEW ORLEANS
NEW YORK
PHILADELPHIA
PITTSBURG, KAS.
PITTSBURGH, PA.
PORTLAND
SALT LAKE CITY
SAN FRANCISCO
SCRANTON
SEATTLE
SHREVEPORT
SPOKANE
SPRINGFIELD
ST. LOUIS
TERRE HAUTE

RED CROSS SEMI-GELATIN is a low freezing explosive designed particularly for wet work. It will not freeze until water freezes, and thaws when ice melts.





E. I. DU PONT DE NEMOURS POWDER CO. Wilmington, Del., U.S.A.

COPYRIGHTED BY E. I. DU PONT DE NEMOURS POWDER COMPANY, 1910

Send for a copy of these Books

The Hardening of Cement Under Water ALSO

The Hardening Process of Hydraulic Cements

By Dr. W. Michaelis, Sr.

Papers read before the German Portland Cement Manufacturers at Berlin, Germany, March 9, 1909

Translated by Dr. W. Michaelis, Jr.

PRICE, FIFTY CENTS EACH

Cement & Engineering News, - - 22 Fifth Avenue, Chicago

Cement Mill Superintendents

who have sat up nights working in the heat and dust of kilns endeavoring to coax red hot clinker elevators into operation

KNOW

Tisco Manganese Steel Chains

PAY

Purchasing agents who keep records of the life of parts

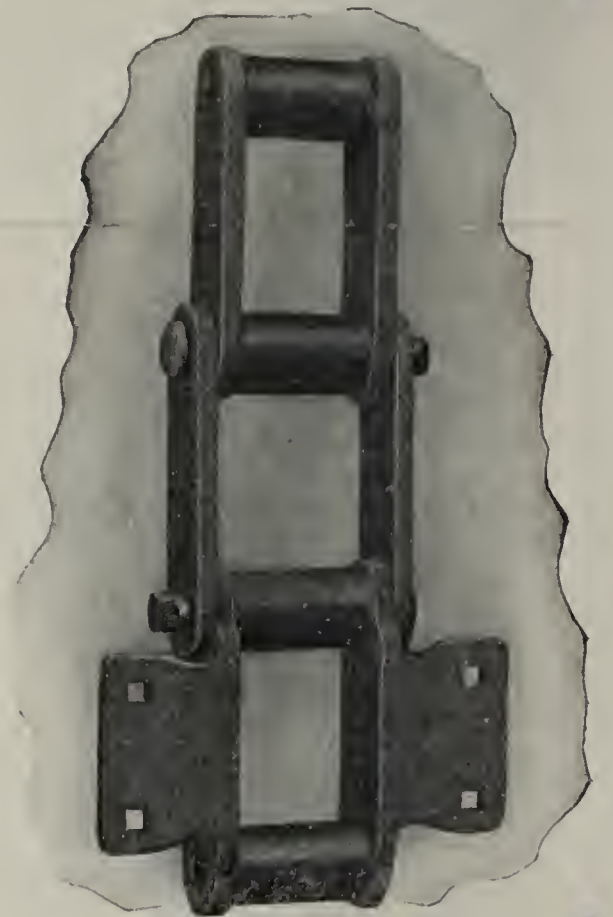
KNOW

that TISCO applications show ultimate economy.

Not how much per foot, but how many thousands of barrels will a dollar's worth of Chain handle!

Detachable Chains for transmission in places of wear and tear.

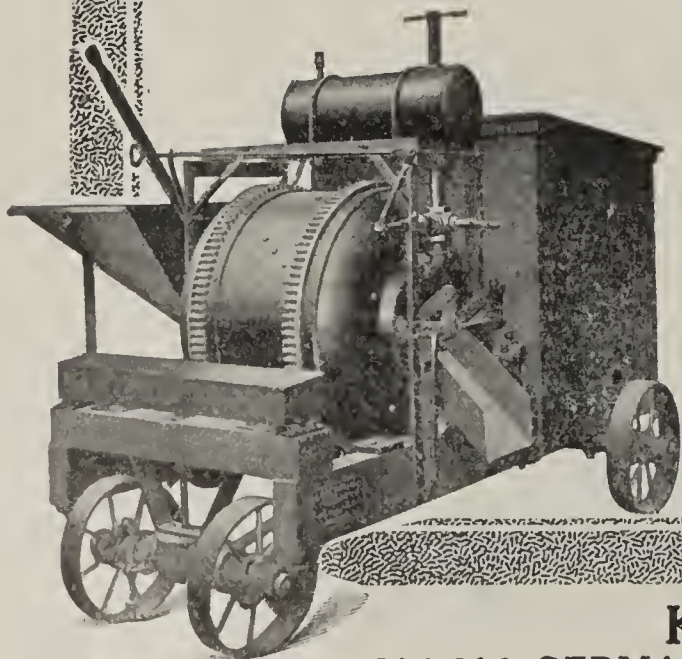
**TAYLOR IRON & STEEL COMPANY, HIGH BRIDGE
NEW JERSEY**



Tisco Combination Chain No. 111

By Any Standard of Quality The Koehring Concrete Mixer Is Peer

In Quality of Product
—Quantity of Output—
Manual Labor Saved
and Dependableness
of The Machine—
None Other Excels.



THREE independent mixings in the one drum, each performed by a positive mechanical force, with no sharp angles or corners is a guaranty of quality of mixing.

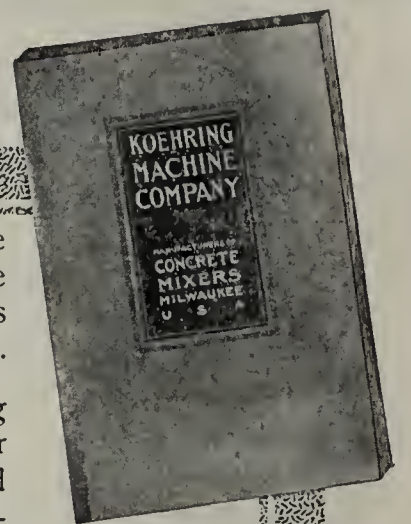
Lifting and pouring from the side, casting alternately from end-to-end, breaking over against heavy cast iron heads of the drum and a constant pouring off the inner end of the discharge chute represents a rapidity of mixing no other equals.

Discharging by merely raising the inner end of the discharge chute and always taking out the exact quantity desired, is manual labor economy you know is the minimum.

The heaviest constructed drum on any mixer, resting on trunnion rollers placed close to the ends, the rollers cast with wide faces, chilled as hard as tempered steel, and a double gear drive with pinions placed high to prevent binding in case the drum settles, comprises a dependableness the greatest mechanical genius will never question.

Built in types and sizes for every requirement; equipped with gasoline, steam or electric power.

It's chock full of dollar-saving quality—quality in the concrete and quality in the machine. Ask for "Catalog B."



KOEHRING MACHINE COMPANY
614-616 GERMANIA BUILDING MILWAUKEE, WIS., U. S. A.

CEMENT BOOKS

How to Use Portland Cement	- - -	50 Cents
Cement Sidewalk Construction	- - -	50 Cents
Hollow Concrete Building Block Construction		50 Cents
Monier Cement & Steel Construction	- -	50 Cents
The Constitution of Hydraulic Cements	-	50 Cents
<i>(By DR. W. MICHAELIS, Sr.)</i>		
The Hardening Process of Hydraulic Cements		50 Cents
<i>(By DR. W. MICHAELIS, Sr.)</i>		
Architects & Engineers Handbook of Reinforced		
Concrete Construction, Paper Cover	-	\$1.00
Cloth Cover	- - -	2.50
<i>(By L. J. MENSCH)</i>		

Delivered Free on Receipt of Price.

Address Cement & Engineering News
22 Fifth Avenue, Chicago



None Just as Good

ATLAS PORTLAND CEMENT

produces uniform work of the best quality. It is not good in one spot and bad in another. It produces a building as permanent, lasting and durable as stone. It gives you a one-piece house, every inch of which is fireproof and sanitary. Be sure you get the right cement—Atlas—the cement of which the United States Government bought 4,500,000 barrels for use in building the Panama Canal.

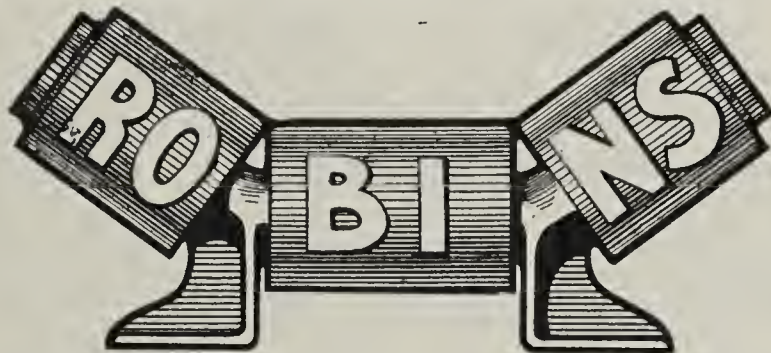
Send for these Books:

Concrete Houses and Cottages, Vol. 1—Large Houses	\$1.00
Vol. 2—Small Houses	 1.00
Concrete Country Residences (out of print)	 2.00
Concrete Cottages (sent free)	
Concrete Construction About the Home and On the Farm (sent free)	
Reinforced Concrete in Factory Construction (Delivery Charge)	10
Concrete in Railroad Construction	 1.00
Concrete in Highway Construction \$1.00	Concrete Garages (sent free)

THE ATLAS PORTLAND CEMENT CO.

Dept. 3, 30 Broad St., New York

Largest Output of Any Cement Company in the world—
 Over 150,000 Barrels Per Day.



BELT CONVEYORS

For Use in

Cement Plants

Have No Equal

We have some interesting data on this subject which is yours for the asking.

Robins Conveying Belt Co.

THOMAS ROBINS
 President

Passaic, N. J. C. KEMBLE BALDWIN
 Chief Engineer

NEW YORK

CHICAGO

"Safest to use, because richest in Bitumen"

"Pioneer"

OUR asphaltic products were first introduced in 1896. For 14 years they have been undergoing the hard practical tests of every day use, and Engineers of repute in all parts of the United States are specifying "Pioneer" Asphalt materials today, because these materials have proven superior to all others.

Wherever there is a reservoir to be waterproofed specifications should be adopted which will prohibit the use of an inferior grade of asphalt. Wherever pipe line construction is in progress the question of *protection and preservation* of the pipe ought not to be decided upon mere claims, but the rigid demands of *specifications that are safe* should be enforced as a check upon lax methods and inferior materials.

"Pioneer" Reservoir Waterproofing Asphalt "Pioneer" Mineral Rubber Pipe Coating

Here are two commodities that will meet the demands of the specifications suggested. They are not experimental, but have both been used with the highest success for years, and under the severest conditions.

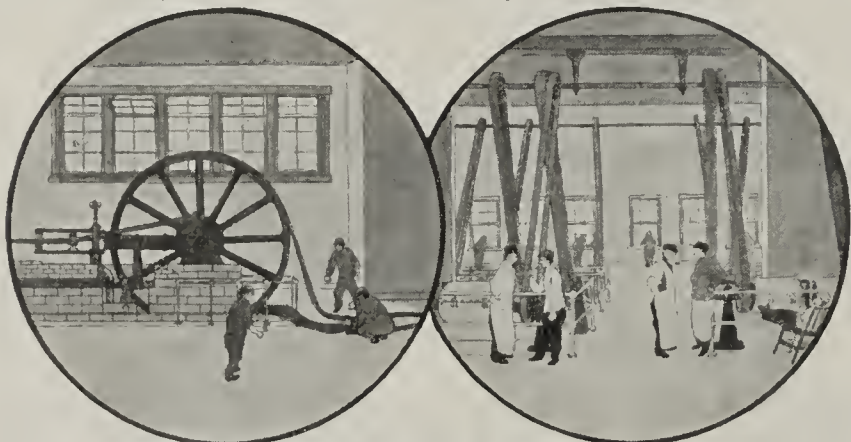
Over 99½% Pure The superior quality of our asphalt is a *proved-out* proposition—a *known quantity*. Our own mines in Utah contain immense deposits of the purest hydro carbon known, our Gilsonite analyzing over 99½ per cent pure bitumen. In any true technical comparison of values "Pioneer" Mineral Rubber Pipe Coating and "Pioneer" Reservoir

Waterproofing Asphalt will readily demonstrate the superiority which has made them practically non-competitive. **Specifications** Send for our specifications and be safeguarded against those asphalt (which are offered as being equal to "Pioneer") the employment of which has, in spite of claims, proven them to be inefficient.

The American Asphaltum & Rubber Co.
600-614 Harvester Bldg.,
Chicago, Ill.

A
14
Year
Record
of Success

NOT THE NOON HOUR



REPAIRS ON THE MAIN DRIVE.

Perhaps this has happened in *your* plant? The belting gives out. Machinery stops. Hands idle. But expenses run right along. Such mishaps can be avoided and highest efficiency permanently assured by using

RELIANCE Guaranteed Leather Belting Repair Bills Reduced

For Tube, Ball, Griffin and Fuller Mills it is unsurpassable. Every Reliance Belt for cement work is protected by a special dressing.

Write for booklet.

Chicago Belting Company
12-22 Green St., Chicago

Branches: New Orleans, 431 Gravier St. New York, 71 Dey St.
Portland, Ore., 94 First St. Philadelphia, 234 N. Third St.



WATERPROOF-CONCRETE AT MINIMUM COST

by admixture of

CROWN HYDRATE LIME

Absolutely Safe

CROWN HYDRATE is a basic mineral and contains neither magnesia nor free lime to cause injury by expansion. It will not interfere with final set and hardening of cement, consequently, has no weakening effect on concrete. To the contrary.

THE TENSILE STRENGTH

Of all cement mixtures exposed to air is increased, and the permanent hardness contributed to, giving a structure of tough, rather than brittle texture.

THE PRINCIPLE

Of water-proofing concrete with Crown Hydrate is to fill voids in initial construction and air holes left by evaporation of excess moisture, thus bringing the aggregates to such a density that no water can penetrate.

THE COST

Of Crown Hydrate is extremely low and means but little or no additional expense to secure a cement mixture impervious to water. No extra labor or time is required to apply the hydrate, and aggregates are brought to a maximum density with less effort than in case of straight cement mixtures. The much desired even, white, appearance can be secured at no extra figure and without surface efflorescence.

THE PROBLEM

Of constructing non-expensive, water-proof and white artificial stone is solved by the addition of Crown Hydrate.

REMEMBER, poorly made hydrate containing magnesia is dangerous and may ruin valuable construction. Protect yourself against failure by specifying and insisting on Crown Brand Hydrate Lime.

Manufactured only by

Marblehead Lime Company
KANSAS CITY CHICAGO

CEMENT

.....AND.....

ENGINEERING NEWS



Harold Walker Residence, Denver, Colo.
Biscoe & Hewitt, Architects.
Medusa White Portland Cement Used in Exterior Stucco.

CEMENT AND ENGINEERING NEWS

[PUBLISHED MONTHLY]

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue

Cable Address—"Seaferts" Chicago.

Entered at the Post Office at Chicago, as Second-class matter, July 21, 1896
under Act of March 3d, 1879.

Subscription	\$2.00 Per Year
Foreign Subscription	\$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON	Advertising Manager
---------------------------	---------------------

CHICAGO, FEBRUARY, 1910.

LESSON TAUGHT BY LAST INTERNATIONAL CONGRESS.

The last Congress of the International Association for the Testing of Building Materials, which held session during the second week of September 1909, at Copenhagen, was certainly one of the most successful of the five international meetings that have so far taken place. It was splendidly organized and admirably conducted by the able president Mr. Foss. The benefit derived from this gathering of engineers of all countries will become known to the engineering world in due time, namely as soon as all papers and discussions will be published in various languages and when the work of the permanent Committees will be finished, to whom a number of important questions have been referred for final decision.

During the next meeting of the Association, the United States has offered to be the host of the foreign nations. The sixth Congress, therefore, is going to be held in New York in 1912.

In extending this invitation, we assume a great responsibility and take upon ourselves duties, which we hope to discharge as ably and cheerfully as other nations have done heretofore. Yet, although we are accustomed to seeing international meetings go on in this country every day—for the United States represents a permanent meeting place of all nations—we must be aware of the fact, that in this special case we are going to welcome to our shores a multitude of engineers unacquainted with the ways of the country and who do not stay long enough to gradually become accustomed to American methods. For this reason, we have to look out for their bodily comfort as well as for an interesting presentation of the engineering problems to be discussed.

The main object of the Congress is, of course, to give the members of the Association an opportunity to discuss orally, in the course of several days, the many points of interest, about which opinions have been exchanged in writing and in print during the three years preceding the meeting. Consequently, as much time as possible should be spent on useful discussions, and the unavoidable banquetting and frolicking, which, because frequently extended beyond reasonable measure, kept away many a learned man from similar meetings, should be confined to a minimum. No time should be given to amusing lectures on scientific subjects, no matter how interesting they may be. This was rightly criticized during the last meeting, at least in one instance, when a very lengthy

paper was read accompanied by stereopticon views, which did not come within the programme of the Association. Similar entertainments are welcomed only by the great number of men who join such assemblies for the sake of getting pleasure out of them and for meeting friends or becoming acquainted with men of the profession. To the engineer, however, whose duty it is to travel a great distance with a view to seriously discuss business methods and who has to make use of his time and hopes to achieve his object in the shortest time possible, such papers are decidedly unwelcome. There have been even cases, during former meetings, in which, in the opinion of a number of engineers, such lectures appeared to have been put in on purpose with the object of preventing the other party from presenting his views. As we Americans are rather fond of the spectacular, we do well to look out that the next programme of the Congress does not contain papers which may appear a waste of time to many of our guests.

The highest duty, however, of every engineer who is going to attend the meeting is that he makes himself thoroughly acquainted with the history and the aim of the Association and with the papers that have been presented in the past, so that he knows exactly what has been accomplished by the Association and how matters stand. Neglect in this particular point has been one of the most unpleasant surprises during the last Congress, in as much as the official representative of the United States, or at least of large cement interests, repeatedly made lengthy speeches and proposed to the Association the adoption of certain rules or the investigation of some engineering problems of common interest; but had to be told, after having detained the assembly for a considerable length of time, that the subject he suggested had been discussed by the Association many years ago and formed a part of the work of a special permanent Committee. If official speakers are so insufficiently prepared, what can be expected of other engineers who frequently join the discussion of papers and cause great confusion on account of not being posted on the subject or because they are not familiar with the three official languages of the Association, French, German and English, and often do not hear what has just been discussed in a language unknown to them?

A point which will greatly contribute towards bringing about an amicable understanding during a debate, is that we have to be prepared to make concessions and that we do not stubbornly adhere to our views and expect other nations to give in in every instance. Only in this way, we can arrive at universal standards. An unfriendly conduct of this nature on the part of the German engineers towards the French was, for instance, the cause of not reaching an understanding on an important point at issue during the last session of the Association, which otherwise could have been settled definitively. Now United States engineers, as well as people in general, are of the same unyielding disposition as the Germans, a feature unfortunately characteristic of thriving nations. That this is true has been proven by the withdrawal of a great number of American engineers from the list of membership of the International Association of which they formed a part in the early years of the Association. The reason for their retirement was their disappointment at the European engineer's slow progress in adapting himself to American ideas. We had better remember all these details, lest we anticipate too much from the next Con-

gress. If every one of the American engineers attending the Congress keeps this advice in mind, we shall certainly not act contrary to the laws of hospitality and shall be satisfied with the outcome of the meeting, even if, during the debates, we do not enforce our wishes in many instances.

We have about two years in which to prepare ourselves for the great event. The Cement and Engineering News, therefore, will make it a point to publish during this time the most important papers, which have been read before the International Association or at least abstracts of them, and especially the last reports of the permanent Committees, so that every one who wishes to attend the meeting in 1912, has an opportunity to post himself on what has been discussed by the Association during the past 20 years of its existence and knows where the discussions left off.

It goes without saying that a study of these debates will furnish a great deal of information to every engineer engaged in cement manufacture and concrete construction, as the European countries are undoubtedly far ahead of us in some respects. While we may surpass them in quantity of manufactured cement, they certainly excel us in scientific research and technical examination, because they have their constructions under observation for a longer period.

THE HARDENING OF HYDRAULIC CEMENTS.

The followers of Dr. W. Michaelis, Sr., increase in number, as the present contribution by Dr. G. Becker (taken from the *Tonindustrie-Zeitung*) on the interesting subject of the hardening process of the hydraulic cements shows:

Dr. Becker sums up the results obtained from experiments carried on for many years. Although his laboratory work is still going on and is not expected to be concluded before a number of years, he is in a position to endorse the colloid theory of Michaelis in all essential points and to corroborate the statements made by Dr. Michaelis, Sr., namely that a process of crystallization can never lead to a water-mortar and that the colloids, formed by the decomposition of the cement upon gauging it with water, harden by loss of water. The novel feature in Becker's experiments is to be found in the laborious efforts made to establish the imperviousness and semi-permeability of the colloidal films in question, namely of films of colloidal silica, alumina and iron oxide which coat the outside of the cement grain. These colloids are permeable in the beginning, but, according to his experiment, become impervious by the precipitation of calcium hydrate on their surface and harden in time through loss of water which is extracted by the hitherto unaffected core of the cement grain.

The deductions Dr. Becker draws from these experiments are exactly the same as those published by Michaelis for the last ten years, although Becker words the explanation of the hardening of the colloids in a different way, that is to say more in accordance with modern views on osmotic pressure and impermeability and semi-permeability of colloidal films or cell-walls. The following is a verbal translation of Dr. Becker's article:

In his papers on The Hardening Process of the Calcareous Hydraulic Cements Dr. W. Michaelis, Sr., as the first calls attention to the semi-permeability

and impermeability of certain gels and hydrogels and makes use of these properties in explaining the hardening of cements. However, he does not sufficiently prove these facts.

During my experiments with cements it occurred to me that the hardening process of hydraulic cements might possibly show features analogous to those which can be observed in the course of the development of the plant-cell and during its subsequent transformation into wood.

When, in the fall of 1905, I expressed this opinion for the first time, I was ridiculed by most cement experts. Fortunately Professor Le Blanc did not reject my views and thus encouraged me to continue my experiments on the permeability of colloidal films. Therefore, it became of great interest to me to read the publication by Professor Ambronn in the *Tonindustrie-Zeitung* (1909, p. 270), as Ambronn likewise explained certain processes in the development of the plant-cell in the same way as I did; his work differed from mine only in as much as he conducted his experiments in the opposite direction.

He who experimented with semi-permeable films and examined their behavior towards various salt solutions knows what time and endurance similar experiments require. As my work has not been completed as yet, I am not at liberty to publish the details of the results obtained, but should like to say that in the case of calcium hydrate impervious films are obtained, if silica hydrate is precipitated in the proper manner in a clay cell customary for similar osmotic experiments and if a calcium hydrate solution is allowed to act upon it under the necessary precautions. Alumina hydrate yields likewise such impervious films. On account of the decomposition which calcium silicates and calcium aluminate undergo in contact with water or lime water, we are entitled to assume that also by the action of water upon cement the same conditions are created which lead to such semi-permeable films. The chemical composition of these films I am unable to state. My experiments seem to indicate that silica hydrate proper is not impervious to calcium hydrate, but that it becomes impervious in the course of time through the action of the calcium hydrate upon it, which would suggest a chemical combination of calcium hydrate and silica. In the case of alumina matters are different. A clay cell filled with alumina hydrate and calcium hydrate solution and immersed in pure water proves very soon the imperviousness of the alumina hydrate. This coincides with practical experience, as a cement hardens the faster the higher the percentage of alumina. The action of gypsum upon cement, in my opinion is to be explained in the following way: Owing to the formation of complex salts the formation of colloidal films is delayed as long as gypsum is available. For the formation of calcium silicates a certain amount of calcium hydrate in solution has to be present, which concentration is delayed by the formation of the complex salts.

The films are of a colloidal character of course. Their semi-permeability or impermeability for colloids can not be taken for granted, but must be proven by experiments. The further study of such films will also be of value for the explanation of the behavior of cements in sea water.

As far as the hardening process proper is concerned I do not share the views of Michaelis in every instance. The colloids, of course, take the most important part in the hardening. On account of their great surface attraction and excellent adhesion they

effectively coat all particles within reach. Furthermore, they form, by themselves or through the influence of calcium hydrate, semi-permeable films and, last not least, represent water reservoirs, which alone enable the cement to continually increase in strength, especially when it is kept in the air. The hardening proper, however, I claim to be due to an exchange between colloids and crystalloids. Colloids, created by the decomposition of the surface of the cement grain, coat the decomposing grain and, in this early stage, represent a honey-combed foam. The cell-walls thus formed are impervious to calcium hydrate, either from the beginning or they become so by precipitation of a certain amount of calcium hydrate on their surface. However, they remain penetrable for water. Owing to this latter fact the decomposition of the cement grain enclosed within the colloidal coating can proceed. New amounts of colloids and calcium hydrate are formed as in the beginning of the decomposing process. These colloids are unable to pass the cell-walls, as colloids are impenetrable for other colloids. Therefore, the colloids subsequently formed in the decomposing process contribute to the strengthening of the colloidal wall or coating formed around the cement grain. The calcium hydrate is partly used up in the formation of the semi-permeable cell-wall; the remainder, which likewise is unable to penetrate the cell-wall, acts as a crystalloid, that is to say goes into solution and consequently exerts a pressure upon the cell-wall which is thus strained and kept in tension in the same way as an inflated rubber bulb. The coating of colloids surrounding the cement grain, therefore, represents a series of cell-walls under osmotic pressure. The concentration of the calcium hydrate solutions inside and outside of the cell-wall is different. The tension to which the cell-wall is subjected must consequently depend upon its thickness and upon the pressure exerted. The osmotic pressure of a solution grows with its concentration. According to my theory, therefore, high-limed cements, if otherwise sound, must yield mortars of high strength, which corresponds with actual experience. On the other hand, the cell-wall must burst, if the pressure from within becomes too great, or in other words, if the percentage of lime is too high. Hence my views lead to conclusions borne out by facts well-known in practice.

In the course of time, the cell-wall grows thicker and stronger and becomes more and more impervious to water. The core of the cement grain, however, which has the same tendency as before to decompose and which exhibits a great desire for water, now extracts water from the cell-wall itself. The cell-wall, therefore, becomes dry and hard and the interior of the cell fills out with crystals of calcium hydrate. These are facts which microscopic sections of hardened cements reveal.

In this brief communication I wish to publish my views on the hardening of cements; however, I must admit some experiments have still to be made to strengthen a number of points of my theory. Furthermore, I desire to say that the statement made by Michaelis, that the semi-permeability of the colloidal films formed during the decomposing process is an important factor, has been proven by my experiments, though, to my knowledge, Michaelis failed to give experimental proofs for these facts. I also acknowledge that Michaelis was the first who called attention to the important part taken by the colloids in the hardening of the hydraulic cements, and strongly support his declaration that crystallization can never

be the cause of the formation of a hydraulic mortar, but that all processes of crystallisation to be observed in the course of the hardening are of secondary importance. If his opponents declare that the microscopic examination of hardening cements reveals mainly formation of crystals, my answer to this is that crystals, owing to their characteristic optic properties, can be recognized in the earliest stages of development, whereas the colloids, on account of their isotropic properties, become recognisable only after they have obtained a certain density, facts which Michaelis sufficiently emphasized in his papers.

AIR-SEPARATORS IN CEMENT PLANTS.

By O. Pfeiffer.

Now that competition in the manufacture of cement has grown as keen in the United States as it has been in Germany for a great number of years, the American cement manufacturer is likewise compelled to economize wherever he can. It is not astonishing, therefore, to see him interested in European discussions of air-separators, as evidenced by numerous reprints in the American cement literature. He notes that the Pfeiffer Air-Separator or "Selector" is being installed in a large number of cement plants every year and comprehends that there must be a reason for it.

Before describing the advantages obtained by our "Selector" I wish to say a few words about the reason why the American cement manufacturer has been slow in adopting this useful device, which would enable him to improve his product. In the first place, as long as the manufacture of cement assured fair profits, there was apparently little reason for figuring very closely and for practising utmost economy. In the second place, the manufacturer of grinding machinery was not interested in seeing part of the grinding mills replaced by separators, which is, of course, the object of the separators. They take out the very finest dust and feed the coarse back to the mills, which are thereby enabled to do better work and to produce more fine cement in a given time, cement which will carry more sand than other brands, that is to say a finished product of a higher cementing value. That this aim is fully accomplished has been proven by more than twenty years of practical experience. Nevertheless, there are parties who, influenced undoubtedly by manufacturers of other machinery, spread the most untruthful information on the subject. In time, such statements find their way even into technical books, where we read, for instance in Eckel's book on "Cement, Limes and Plasters," the following paragraphs:

"Practically every writer who has discussed the crushing practice at American Portland cement plants has noted and deplored the absence of separators. In spite of this general unity of opinion on the subject, only a few plants, to the writer's knowledge, are now equipped with any separators, and none have as many as might be used. In view of the fact that American Portland cement practice, so far as crushing methods are concerned, is to-day far ahead of crushing practice in ore-treatment works, this apparent disregard of one great principle of general crushing practice seems to require some explanation. It will not do merely to assume that separators are omitted because the advantages to be gained from

their use are not understood by designers and managers of cement plants, for that amounts to charging a peculiar expert clan of mechanical experts with gross ignorance. In the opinion of the writer, the general omission of separators is entirely justified by certain conditions peculiar to the process of Portland cement manufacture, and the general use of separators would be a serious error in this business. As this opinion may not be generally accepted, and as the grounds on which it is based have never been discussed in print, the advantages and disadvantages of separators may be worth discussing in some detail. This is particularly necessary because the writer realizes, and freely admits, that the views which he holds may be proven to be based on incorrect premises. In that case a relatively brief series of experiments, which could be carried on in any cement mill, would be of great service to all interested in the technology of the cement industry."

"In crushing any material, if the only things to be arrived at are low cost of crushing per ton of product and high tonnage of product per hour, one fact may be regarded as firmly established; that is, that it is an error to feed to any machine (of the series of reducers employed) material fine enough to go to some machine further along in the reduction process. Beginning with the first or coarsest crusher of the series, while most of its product will only be fine, a certain part of its product will be sufficiently fine to be passed on to the third or even fourth reducer. If this be done the product per hour of the series will be greatly increased, each machine will be working on material of fairly uniform size, and the cost of crushing per ton will be greatly reduced."

"Applying this to the Portland cement industry it is probably safe to say that in a series of reducers (consisting for example of a coarse crusher, a fine crusher, a Williams or ball mills and tube mills) the product per hour of the series could be increased at least 50 per cent by simply placing separators between each of the steps of the series. The cost of crushing per ton of product would incidentally be decreased, but not in quite the same ratio."

"In view of the enormous gain in output that would be secured by the use of separation, as noted in the preceding paragraph, it is evident that the disadvantages attending their use must also be very great, for otherwise every cement mill would now be fully equipped with them. The principal disadvantages attending the use of separators in a Portland cement plant are two:

"1. Separators destroy the uniformity of the product.

"2. Separators prevent the attainment of very great fineness.

"These two objections will be discussed in the order named. It is probable that the second is in actual practice the more important."

"Throughout the entire course of cement manufacturing processes, from the moment the raw materials enter the mill until the finished cement is packed, the object of the manufacturer is to attain a product as nearly homogeneous as possible. The quality of the cement depends in large part on the extent to which his attempts to secure absolute uniformity have been successful. In the opinion of the present writer, one great objection to the introduction of separators into cement practice is that their use will tend to destroy this uniformity.

"The action of separators is based commonly on one of two principles. They take advantage either (a) of differences in the weight of particles or (b)

in differences of size of particles. In the first case, the separator, other things being equal, will take out both the finer particles and the particles of lowest specific gravity. In dealing with raw mixtures they will tend to separate the clay particles from the limestone particles. Separators depending for their action on the differences in size between the particles will take out the finer, which, other things being equal, will, of course, be particles of the constituent which is most readily pulverized. Similar effects will be observed if separators be used in the progress of clinker grinding, for the lighter-burnt, more readily ground portions will be separated from the rest and the uniformity of the product will be destroyed."

"If in a plant not using separators the finest grinders be adjusted to give a product of which 95 per cent passes a 100-mesh sieve, a very large proportion of that product (say 70 to 75 per cent) will pass a 200-mesh sieve. If separators were installed throughout the plant, and the same adjustment of the fine grinders maintained, a product passing the same 95 per cent through a 100-mesh sieve would probably pass not over 60 per cent through 200-mesh. As it is the percentage of very finely ground particles which gives the chief value to the cement, the use of separators on the clinker-grinding side of a cement plant would seem to be inadvisable. In pulverizing raw materials the same objection can be made, though it is not so important as in grinding the finished product."

The statements contained in the former paragraphs are merely based upon theoretical reflections, and not on practical experience. They show gross ignorance on the part of the writer with regard to the use made of separators at cement plants. The writer of these paragraphs may possibly be familiar with separators installed at ore-mills, but has certainly never seen a separator, properly run, at a cement plant. Of course, if an effort would be made to increase the output of the grinding machinery 50 per cent, as in the case of the ore-mill described by the writer, the finished cement would certainly not be fine, but rather coarse. In grinding cement, separators are run at a much lower speed, so that both cases can not possibly be compared nor deductions be drawn from the grinding practice at ore-mills with regard to the possible application at cement plants. In the same way experiments must yield misleading results, if they are conducted by men who try to apply their experience with separators obtained at ore-mills to cement mills.

In more than a hundred cases, in which our separators have been installed at cement plants and in which the two points mentioned by Eckel, namely destroying of the uniformity of the product and preventing of great fineness of the finished product, have been carefully studied, it has been proven that, upon running of the separators at a reasonable speed, neither the uniformity of the raw mixture is destroyed nor that of the composition of the finished cement and that in all cases a commercial cement of much greater fineness and sand carrying capacity is obtained. Also at American Portland cement plants equipped with our separators the same experience has been made. In order to cite only a single example, I mention, as a well-known fact, that the cement of the German-American Portland Cement Co. is far superior to many well-known brands, for instance to Atlas, Lehigh, Vulcanite and so forth, and surpasses these latter in strength not only now and then, but every day of the year. This statement is true to such an extent that mortars made of cement and sand in the proportions of 1:4 yield the same strength as

those made from the other brands in the ratio of 1:3. The same applies to other plants using our separators and fully contradicts Eckel's statements.

Of course, it can not be denied that it is possible to run air-separators at so excessive a speed that coarse cement is taken out at the same time with the very finest particles and that, in the case of poorly burnt cement, the part which crumbles into dust can be taken out first and separated from the well-burnt cement, if the clinker is simply crushed, so that the disintegrated cement alone represents the fine. However, improper use made of a newly installed machine or poor results obtained with it during the time of experimenting are not circumstances fit to disprove the excellent results obtained with air-separators at cement plants.

The fact that our separators are on the market for more than twenty years and that most European cement mills make use of them should be sufficient to prove that they possess some merits. If this information should not suffice to contradict Eckel's statements, the following data taken from actual practice are probably in a position to demonstrate to every one's satisfaction that cement manufactured with separators is finer than cement ground without the aid of separators. These tests are made with rotary kiln cement as well as with cement originating from upright kilns and refer to machinery without separators (standard cement) and with separators (fine cement).

The results I hope will not fail to make an impression upon the American cement manufacturer who realizes that, also in the United States, cement will be bought and paid for from now on according to its sand carrying capacity, that is to say according to its real value.

No. 1. Portland Cement from Upright Kilns:

Standard Cement19.8% residue on 200 mesh sieve
Fine Cement 2.0%

Compression strength after 28 days:

1 part Standard Cement and 3 parts sand....4050 lbs per sq. in.
1 part Fine Cement and 3 parts Sand.....5150 " " " "

Hence Increase in Strength: 28%

0.8 parts Fine Cement and 3 parts sand....3990 lbs. per sq. in.
0.85 parts Fine Cement and 3 parts sand....4145 " " " "

Concrete Cubes.

1 Standard Cement, 3 Sand, 6 Stone.....2040 lbs. per sq. in.
1 Fine Cement, 3 Sand, 6 Stone.....2940 " " " "

Hence Increase in Strength: 44%

0.85 Fine Cement, 3 Sand, 6 Stone.....2220 lbs. per sq. in.
Thus, in the case of 0.85 parts of Fine Cement the compression strength is higher than in the case of 1 part of Standard Cement.

No. 2. Portland Cement from Rotary Kilns:

1 part Cement and 3 part Sand.

Compression strength after 28 days:

Standard Cement: Residue on 200 mesh
sieve, 19.8%4140 lbs per sq. in.
Fine Cement I: Residue on 200 mesh
sieve, 2.0%5730 " " " "
Fine Cement II: Residue on 200 mesh
sieve, 0.5%6390 " " " "

No. 3. Portland Cement from Upright Kilns:

1 part Cement and 3 parts Sand .

Tensile Strength:

After7 days.....28 days.
Standard Cement315 lbs.540 lbs.
Fine Cement405 lbs.697 lbs.

Compression Strength:

Standard Cement3740 lbs.5250 lbs.
Fine Cement4800 lbs.6600 lbs.

No. 4. Portland Cement from Upright Kilns:

1 part Cement and 3 parts Sand .

Compression Strength: after7 days28 days
Standard Cement3240 lbs.5535 lbs.
Fine Cement4755 lbs.7200 lbs.

PLASTER, OVERBURNT GYPSUM AND HYDRAULIC GYPSUM.

By M. Glasenapp.

An essay, describing the various products obtainable by heating and calcining of native gypsum, based upon an extensive microscopical research, intended to throw light upon the excellent properties of some kinds of burnt gypsum and to end the confusion existing in the classification of gypsum products. Illustrated with numerous photographs of microscopic sections.

Translated by Dr. W. Michaelis, Jr.

(Copyrighted 1910, by William Seafert.)

The chemical and physical properties of gypsum and of the various commercial products obtained from it by heating and by calcining have so far been studied very little, so that the most erroneous opinions on this subject are daily expressed by men producing and handling these cements.

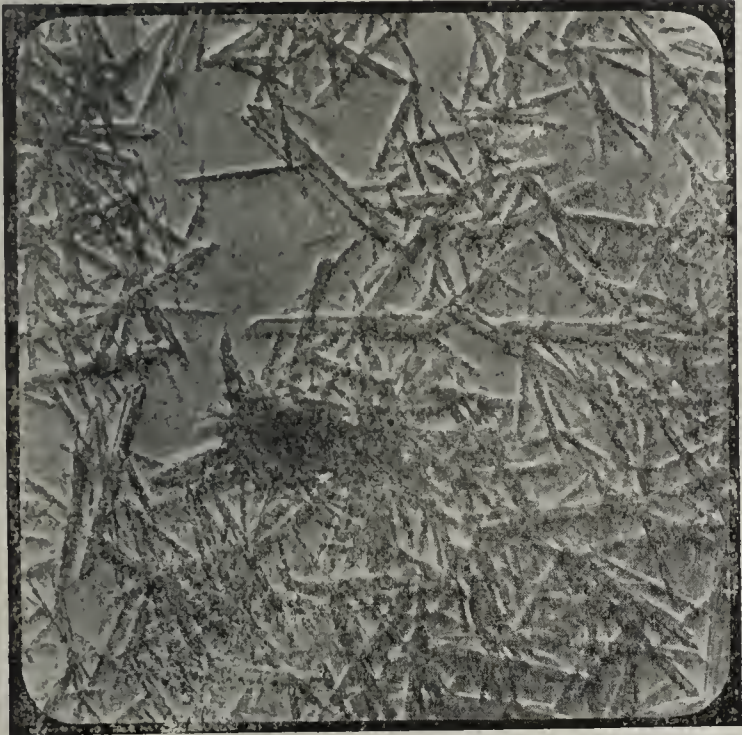
Every one interested in the manufacture of gypsum and in its wide application, therefore, will welcome the news that Professor M. Glasenapp has made an exhaustive research of the properties of the various products obtainable by heating of raw gypsum at different temperatures. Professor Glasenapp is in charge of the technical laboratory at the University of Riga, Russia, and is considered an authority on building materials. A thorough study of his experiments will greatly benefit every person engaged in the gypsum industry, will serve to spread knowledge among producers and consumers and to make clear a great number of points, about which obscurity prevailed.

The accurate work done by this scientist will save others, in search of information, a great deal of experimenting and will be a guide to them in the practical operation of their plants as well as in the marketing of their products and in the testing of the manufactured articles. Moreover, the conclusions which the experimenter draws from his work contain a number of valuable suggestions how to improve the commercial products, especially hydraulic gypsum and Keene's cement, in order to make them more valuable, and to substitute them for other white cements commanding a high price. The large number of illustrations accompanying the paper can not fail to make the subject lucid and interesting to the reader:

I. PLASTER OF PARIS OR STUCCO GYPSUM:

If ordinary plaster of Paris, representing mainly the half-hydrate $\text{CaSO}_4 + \frac{1}{2} \text{H}_2\text{O}$, is mixed with water and examined under the microscope, a lively process of crystallization can be observed to set in after 5 or 6 minutes. In the beginning very thin needle-crystals form on the cover glass and shortly afterwards also in the liquid and on the particles of gypsum. After 15 or 20 minutes single needle-crystals and groups of them can be seen in great number, and especially the larger fragments of the half-hydrate are covered with needle-crystals radiating from them; also the characteristic twin crystals appear abundantly. As fast as the crystals form, the original particles of the half-hydrate disappear; after an hour, they are completely used up and transformed into crystals, whereby the larger fragments of them become the centers of accumulations of crystals, while the

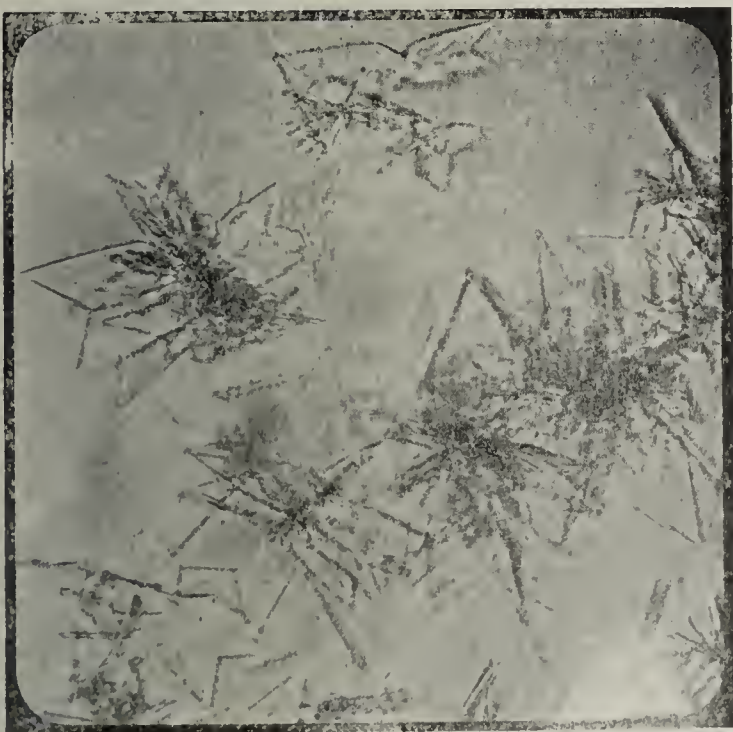
smaller have been converted into isolated star-shaped groups. Cuts No. 1 and No. 2, illustrate the transformation of the half-hydrate into the crystallized di-hydrate. It may be added that this process goes on in the same way, no matter whether the raw gypsum used in the manufacture of plaster was crystallized gypsum or gypsum of a fibrous nature or granular gypsum.



No. 1. Needle-shaped crystals of di-hydrate formed by mixing of plaster of Paris with water. The plaster was produced by heating native gypsum to a temperature of 130 centigrade. Magnified 360 times.

After the same gypsum was heated for several hours to a temperature of 170 centigrade (whereby the amount of water still remained 6.2%, corresponding with the half-hydrate), crystallization began after 3 to 4 minutes and was practically completed after half an hour; only the largest particles required almost an hour to dissolve and to re-crystallize.

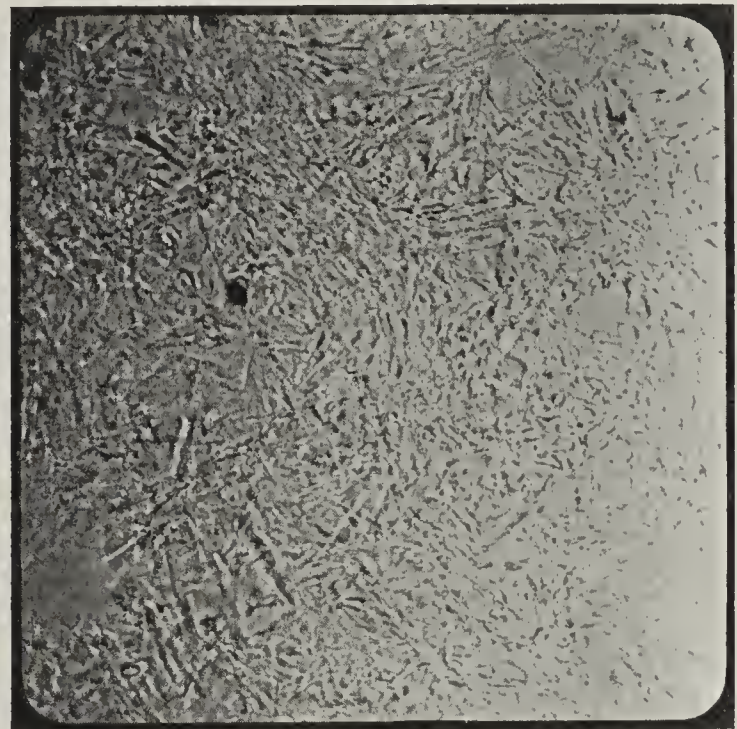
The present state of our knowledge of the hardening of gypsum is that, after having been mixed with water, the half-hydrate, plaster of Paris, and the first anhydrous modification of gypsum, which is supposed to be formed between 130 and 200 centigrade, form



No. 2. Twin-crystals and needle-shaped crystals of di-hydrate formed by the going into solution and subsequent crystallization of the particles of half-hydrate composing plaster of Paris. Magnified 360 times.

over-saturated solutions, from which the di-hydrate precipitates in the shape of small crystals, a process which is finished only after all half-hydrate or anhydrite is dissolved and transformed into crystals of di-hydrate. Apparently the half-hydrate goes into solution more rapidly and crystallizes in a shorter time than the first modification of anhydrite; at least I conclude this from the fact that this first anhydrite, which is considered to be "easily soluble," dissolves the more slowly at the higher a temperature it was produced.

The same process of solution and crystallization, disclosed by microscopical examination of plaster mixed with water, takes place also during the setting and hardening of plaster castings, whereby the ratio of plaster to water may vary within wide limits without materially influencing the time of setting. If the plaster consists only of the half-hydrate, the setting of the casting, according to my observations, coincides with the beginning of the formation of crystals of di-hydrate, and the final hardening corresponds with the complete transformation of the half-hydrate into crystallized di-hydrate. However, if the commercial product contains large amounts of the first modification of anhydrite—hereafter referred to as I. anhydrite—a reaction sets in which accelerates



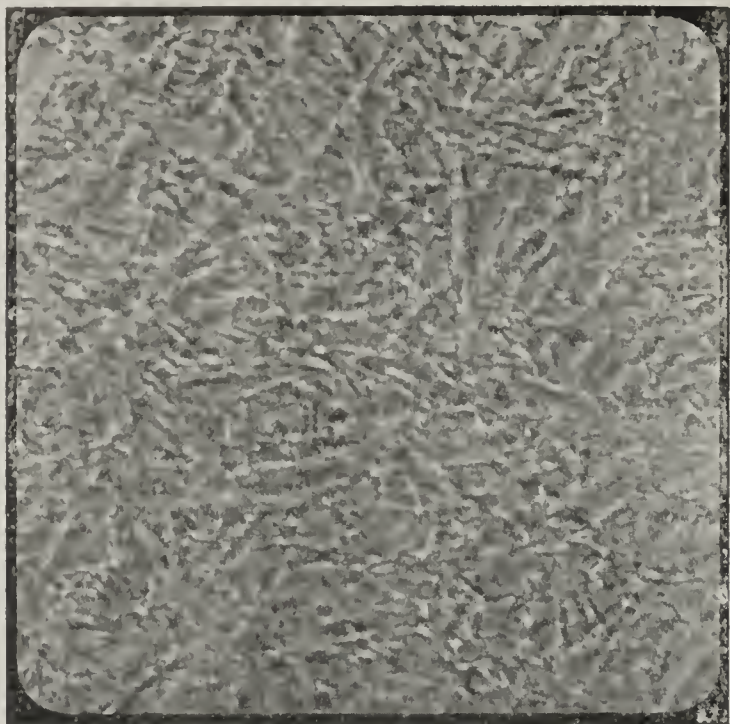
No. 3. Microscopic section made from a piece of a hardened casting of plaster of Paris. The plaster used was very quick-setting. The crystals are very small. Magnified 750 times.

the hardening; this I shall describe later when dealing with the so-called "overburnt gypsum."

Microscopic sections of plaster castings readily show the transformation which the powdered burnt gypsum undergoes upon hardening with water, for, as cuts No. 3 and No. 4 illustrate, the casting consists of a dense network of interlacing needle-crystals of di-hydrate. Also crystal-groups can be distinguished made up of accumulations of twin-crystals and needle-crystals resembling cut No. 2.

A burnt piece of raw gypsum that is to say plaster of Paris in unground form, on the other hand, exhibits an entirely different structure under the microscope. It shows parallel lamination in accordance with the growth of the crystal (see cut No. 5).

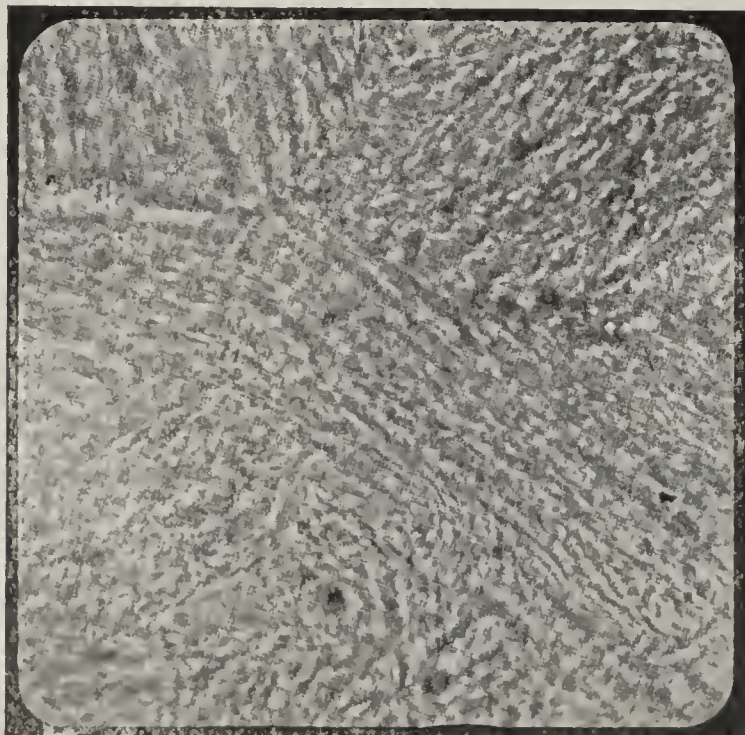
The fact that a process of crystallization is the cause of the hardening of plaster explains the phenomenon that water in the form of steam does not harden it. Plaster is able to set only in contact with



No. 4. Section from a casting of plaster of Paris. The plaster used was less quick-setting than the former. The crystals are larger than in cut No. 3. Magnified 750 times.

liquid water, in which it can go into solution and crystallize.

To judge from even the most recent statements to be found in books on chemical technology, only few chemists seem to be aware of the fact, that a complete transformation of every particle of plaster is an essential point in its hardening. Owing to the greater solubility in water of burnt gypsum over crystallized gypsum, the hardening of plaster of Paris has been attributed to a process of crystallization for some time; yet, this crystallizing has mostly been regarded as of secondary importance. The prevailing explanation was that the partly or completely dehydrated gypsum hydrated, combined with water and hardened, without changing its form or place, that is to say without previous going into solution. The process, therefore, was considered to be similar to the hydration of calcined magnesia and, in many persons' opinion, seemed to resemble the hardening of Portland cement and of hydraulic limes. This erroneous conception likewise led to the belief, that the strength of the casting depended upon the hardness of the native gypsum from which the plaster



No. 5. Microscopic section of a piece of burnt native gypsum not hardened with water. Magnified 750 times.

was burnt. In fact, the difference in hardness between two kinds of raw gypsum is a matter of no consequence. The strength of the hardened gypsum depends solely upon the shape of the crystals, upon their size and upon their more or less close contact. The more slowly the plaster hardens, the larger and stronger the crystals of di-hydrate grow, and the less water is mixed with the plaster the denser and less porous the casting becomes. Moulds which absorb water readily, therefore, require a plaster containing as little anhydrite as possible; furthermore, such moulds call for a liberal amount of water. Admixtures to the plaster, which retard the setting, so-called negative catalysers, create large crystals and consequently are the cause of more resisting and stronger castings.

The literature on gypsum contains contradictory statements about the suitability of hardened plaster for the manufacture of plaster by re-burning it. Most authors say that hardened plaster is unfit for this purpose, but admit they are unable to give a proper explanation. The answer to this is that a piece of hardened plaster consists of a very porous mixture of small crystals of di-hydrate, which, upon burning and subsequent mixing with water, behaves exactly in the same way as when mixed with water for the first time or as any plaster burnt from raw gypsum. This means the fine interlocking needle-crystals which, by the re-burning have been transformed back into the half-hydrate, but which are still of the same porous structure, go into solution and crystallize again as di-hydrate, a process which may be repeated with the same material as often as desired. The only difference in the use of broken pieces of hardened plaster instead of dense raw gypsum is that, in the former case, the raw material for manufacturing plaster is an exceedingly porous and light mass. The consequence of this is, that this re-burnt plaster, as experiments will readily show, requires more water than the denser plaster burnt from native gypsum. Re-burnt plaster, therefore, yields castings which are too light and, for many purposes, not sufficiently resisting.

II. OVERBURNT OR DEAD-BURNT GYPSUM, SLOW-SETTING PLASTER, DEHYDRATED GYPSUM:

The term "overburnt or dead-burnt gypsum" designates, in most people's opinion, a product too slow-setting for practical purposes or not hardening at all. The literature does so far not contain any definite information about the limits of temperature within which this kind of gypsum is obtained. Rohland places the limits between the temperatures of 130 and 525 centigrade. Below 130 centigrade this so-called first anhydrite (I. anhydrite) of the calcium sulphate is supposed to convert into the half-hydrate and above 525 centigrade into hydraulic gypsum. The temperature of 130 centigrade has been adopted by the Association of German Plaster Manufacturers as that beyond which the formation of this anhydrite begins. Whether or not the half-hydrate breaks up at once into anhydrite and steam, as van't Hoff believes, or whether a gradual process of dehydration sets in under formation of various intermediary products, is so far an open question inconsequential for practical purposes.

It is a well-known fact that the anhydrite burnt at low temperatures, say up to 240 centigrade, which, by the way, still contains 0.2 to 0.5% of water, hardens

rapidly and develops fair strength, and, as in the gypsum-kettles customary in practice surpassing of the temperature of 130 centigrade can not be avoided, the commercial plaster of Paris must necessarily be composed of a mixture of half-hydrate and anhydrite, or more or less dehydrated half-hydrate. Gypsum overburnt from a practical standpoint is produced only at higher temperatures, at 300 centigrade and above; but, even at this point, temperature limits can not be defined accurately, as, in addition to the temperature, the time of heating is an important factor. According to Rohland, the anhydrite, obtained by prolonged heating of gypsum at temperatures between 200 and 300 centigrade, is able to hydrate, but loses its capacity to harden. Such widely differing observations naturally surprise and call for an explanation.

The microscopical examination of samples of powdered gypsum, burnt at temperatures higher than 200 centigrade, teaches nothing essentially different from the behavior of the half-hydrate or plaster of Paris towards water. Only the ability of this I. anhydrite to form over-saturated solutions is impaired; it is limited the more the higher the burning temperature has been and the longer the material was heated. Transformation into crystals of di-hydrate takes place in the same manner, but more slowly. The following table gives the various temperatures to which the gypsum was exposed, as well as the time of heating in many instances, and the beginning and termination of the process of crystallization corresponding with them:

Temperature.	Burning Time.	Beginning of Crystallisation	Crystallisation Completed After
107 Celsius		6-7 minutes	1-2 hours
130 Celsius		6-7 minutes	½ to 1 hour
170 Celsius		3-4 minutes	½ hour
200 Celsius	7 hours	30-35 minutes	1-2 days
200-250 Celsius	14 hours	60 minutes	7 days
250-300 Celsius	7 hours	40 minutes	3 days
400 Celsius	½ hour	1¾ hour	17 days
450 Celsius	½ hour	10 days	30 days

As the hardening of the castings of plaster is caused mainly by the transformation into di-hydrate, and as this process of crystallization is the same also for "overburnt" gypsum, the lack of hardening in the case of the latter must doubtlessly be ascribed, wherever it has been observed, to the drying out of the uncovered castings; the process of crystallization, therefore, was interrupted and the casting could not obtain its full strength, which it otherwise would have done. This must happen especially in cases in which the process of crystallization takes a number of days. With gypsum burnt at 200 centigrade the transformation into crystallized di-hydrate is almost completed within 24 hours; only the larger particles take more time, and as, specially in the case of large castings, still a sufficient amount of water remains for crystallization after 24 or even after 48 hours, this explains the fact that gypsum, burnt at 200 centigrade and even above this temperature, unless heated for too long a time, or mixtures of this with standard plaster of Paris, show normal hardening and high strength. Rohland who assumes that only a small portion of the gypsum, its active part, takes a share in the hardening, is therefore mistaken; the entire mass is active, if it be given time and opportunity to exhibit its activity which is greatly diminished indeed. Complete hydration and transformation into di-hydrate without hardening, as Rohland describes it, is consequently out of the question. The term "overburnt or dead-burnt gypsum" is therefore misleading; the proper name for gypsum burnt at temperatures between 200 and 300 centigrade would be "slow-setting."

The process of hardening of such slow-setting plaster shows two distinct phases: In the first place, the plastic dough assumes a dull surface and becomes stiff owing to the transformation of the anhydrite into the half-hydrate. This point is reached after 1 or 2 minutes in the case of gypsum heated to 200 centigrade and after 30 minutes or more with gypsum burnt at temperatures between 250 and 300 centigrade. If further absorption of water is interrupted at this point by a rapid drying process, the stiff plaster is found to contain from 6 to 6.5% of water of combination corresponding about with the half-hydrate. During the second phase, which requires more time, the half-hydrate previously formed goes into solution and crystallizes as di-hydrate. Setting and hardening are, therefore, two well-pronounced processes in this case. Castings that have only time to set yield insufficient strength; they must be given time to harden.

The more the burning temperature exceeds 200 centigrade and the longer the gypsum is heated, the more the anhydrite loses its ability to go back into the state of the half-hydrate and this latter in turn becomes less capable to form over-saturated solutions and to crystallize as di-hydrate, until finally a product is obtained upon which water reacts so slowly that, for practical purposes, it must be considered to be overburnt and worthless. But even this kind of gypsum has by no means lost its capacity to harden, as Michaelis demonstrated long ago by a series of experiments in which gypsum was heated from the lowest temperatures up to intense white heat; all of these products hardened well. However, I must say right here that, at temperatures beyond dark red heat, a product of entirely different properties is obtained, namely hydraulic gypsum which so far was considered to be obtainable at much lower temperatures.

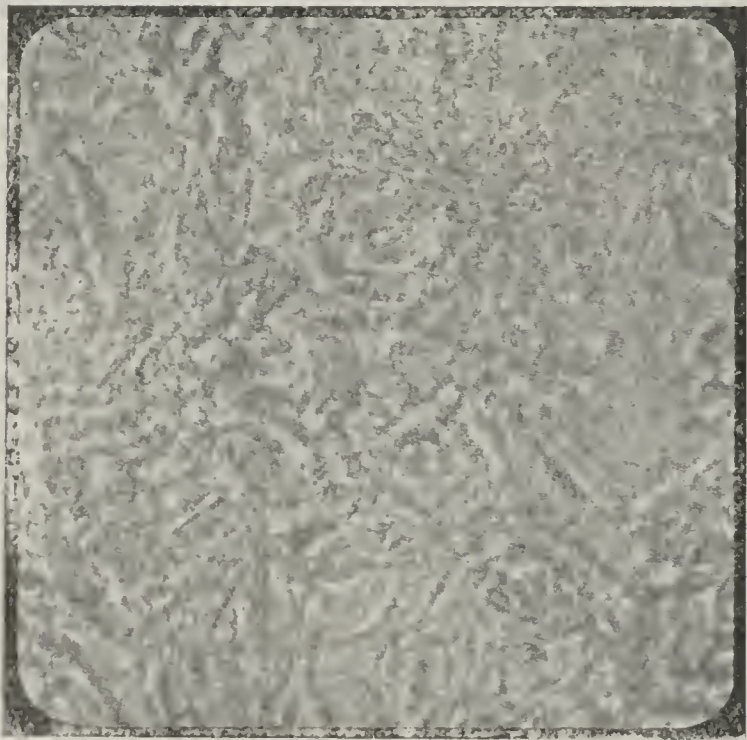
The practice of distinguishing various kinds of anhydrite according to their solubility as "easily soluble" and "insoluble" or "difficult to dissolve" may be permissible for practical purposes, but is not justified from a scientific standpoint, as the solubility decreases very gradually with rising temperatures and as an absolutely insoluble anhydrite has not been obtained as yet. All that can be said about the behavior of the I. anhydrite towards water is that its properties depend upon the burning temperature and upon the time of heating. First anhydrite (I. anhydrite) I call all kinds of anhydrous gypsum burnt below 750 centigrade for reasons to be explained more fully later.

The question, whether or not the various grades of slow-setting plaster, obtainable by the burning of gypsum between 200 and 300 centigrade, can be used in practice, must not be denied, as frequently done, not even, if their hardening takes several days, a time to which we willingly accustom ourselves in making use of Portland cement. Such slow-setting plasters have certainly this advantage over ordinary plaster of Paris that the crystals of di-hydrate grow the larger the more slowly they form, a circumstance beneficial to the grain and the hardness of the casting. The reason, why castings made from ordinary quick-setting plaster are low in strength and possess little resistance towards atmospheric influences, is evidently to be found in the minute size of the interlacing needle-crystals of di-hydrate which, owing to the rapid process of crystallization, have not time to develop and to grow larger. The following table illustrates this point by giving the dimensions of the crystals in millimeters and the corresponding temperatures at which the various kinds of quick-setting and slow-setting plasters have been burnt:

Burning Temperature	Largest Dimensions of Crystals	
	Diameter	Length
107-130 Celsius	0.0025 mm.	0.04 mm.
140 Celsius	0.012 mm.	0.14 mm.
250-300 Celsius	0.075 mm.	0.50 mm.
400 Celsius	0.050 mm.	0.35 mm.
450 Celsius	0.085 mm.	0.60 mm.

The plaster burnt at 400 centigrade was heated only for half an hour; that burnt at 250-300 centigrade, however, for several hours. This explains the difference in the dimensions of the crystals. The first two of the plasters given in the preceding table are quick-setting, the last three slow-setting.

The diameters of the needle-crystals of the plaster burnt at 107-130 centigrade are 30 times smaller than those originating from the plaster burnt at 250-300 centigrade; their sectional areas are, consequently, 900 times smaller. It is, therefore, evident that, other things being equal, a casting made from slow-setting plaster, must show greater strength. Hence, whenever time has not to be considered and increased strength of the casting is desired, as for instance in the case of statues for art-galleries and so forth, experiments with slow-setting plaster seem to be very advisable, preferably with gypsum burnt at a temperature between 250 and 300 centigrade. The moulds may be removed, if necessary, at an early period, but the casting must not be allowed to dry out before the hardening process is completed. The length of time required for the hardening can best be ascertained by microscopic examination. Samples taken from castings made with slow-setting plaster showed that the hardening process of the casting corresponded in time exactly with the development of crystals of di-hydrate in the microscopic preparation. Cut No. 6, represents a section taken from a similar casting, magnified 750 times. A comparison of it with cuts No. 3 and No. 4, giving sections of quick-setting plasters plainly shows the larger size of the crystals of di-hydrate. It may be mentioned, furthermore, that the slow process of crystallization almost exclusively gives birth to long prismatic crystals, while short plate crystals are exceptions.

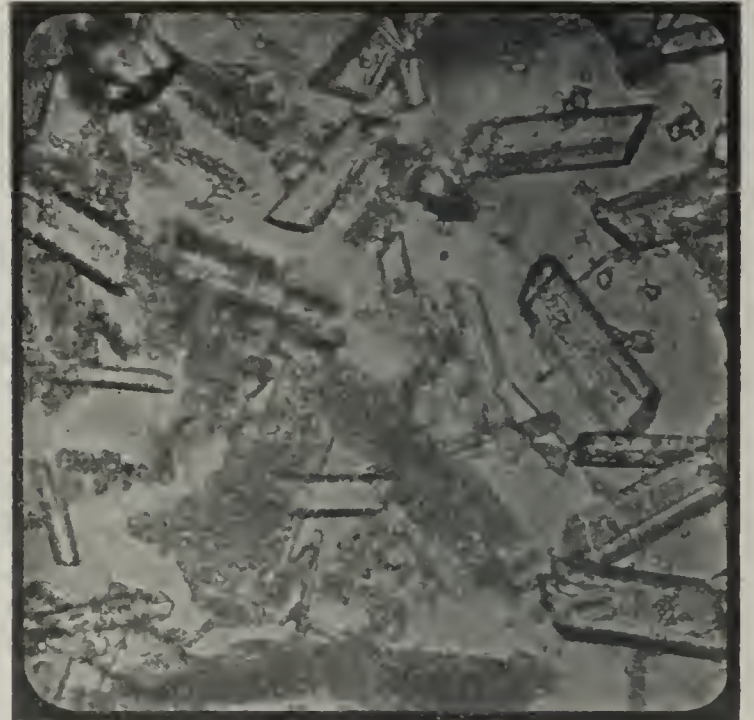


No. 6. Section from a casting made of gypsum burnt at 250-300 centigrade after having hardened for 5 weeks. Compare the size of the crystals with those in cuts No. 3 and No. 4. Magnified 750 times.

The tensile strength of an "overburnt" gypsum, (slow-setting plaster) produced at a temperature of 250-300 centigrade, was found to be, after the completion of the hardening process, 270 lbs. per sq. in., a very

fair strength for plaster indeed. The surface of castings made from it has not the chalk-like appearance of the common plaster of Paris, but possesses a glaze resembling satin or marble; moreover it is harder; yet, it does not obtain the strength of the same plaster mixed with solutions of alum and is likewise far inferior to hydraulic gypsum.

Gypsum which may be called "overburnt" from a practical standpoint, that is to say too slow-setting a plaster, is obtained between the temperatures of 400



No. 7. Transformation of gypsum, "overburnt" at a temperature of 600-700 centigrade, into crystals of di-hydrate by means of alum solution. To be compared with No. 1. Magnified 360 times.

and 750 centigrade, yet even at lower temperatures, if the heating is prolonged for several hours. The lower temperature limit can, therefore, not be stated at all, while 750 centigrade may be regarded as the upper limit, because beyond this temperature hydraulic gypsum is formed.

Although worthless by itself, the plaster burnt at this interval of temperatures can be made to act very energetically, namely by mixing it, instead of with pure water, with solutions of certain salts which accelerate the hardening process of the common plaster (positive catalysers). Thereby, the "overburnt" gypsum regains its capacity to form over-saturated solutions from which the di-hydrate crystallizes. Gypsum burnt between 600 and 700 centigrade, which, according to Rohland's statements, is unable to act even in the presence of positive catalysers, begins to form crystals of di-hydrate after about 45 minutes, if mixed with a solution of potassium-alum and observed under the microscope. After from 30 to 48 hours it is completely transformed into crystals of di-hydrate. Cold saturated solutions of this salt yield plate-crystals and short prisms (cut No. 7 shows this transformation), while half-saturated and one-quarter saturated solutions chiefly give birth to long prisms. The time required for complete transformation into the crystallized di-hydrate amounts to about 30 hours in the case of saturated solutions and to approximately 48 hours for one-quarter concentration. After 2 days the hardening process is completed in every instance. A gypsum of this kind possesses almost the strength of hydraulic gypsum and of Portland cement; it is so hard that the thumb-nail will not indent it. The tensile strength was found to be as high as 525 lbs. per sq. in.

To this group likewise belongs Keene's cement man-

ufactured by mixing of plaster of Paris with alum solution and subsequent heating to red heat of the formerly hardened mass. The powdered calcined product is afterwards mixed once more with a solution of potassium-aluminum sulphate. The same result, however, is obtained by omitting the first hardening with alum, that is to say by "overburning" the raw gypsum in the first place and then gauging the powdered anhydrite with alum solution.

Another method of making "overburnt" gypsum active and of accelerating the hardening process consists in admixing small amounts of quick-setting common plaster. A gypsum, which was burnt at 550 centigrade and mixed with water, was still soft after 7 days and showed no sign of hardening. Chemical analysis proved it to contain only 2.90% of water of combination. The same gypsum, mixed with only 10% of its weight of a plaster burnt at 107 centigrade, contained 14.88% of water of combination after the same period; it began to set after several hours and developed fair strength. This behavior must be considered a proof of Ostwald's germ theory which attributes the lack of hardening of "overburnt" gypsum to the circumstance that it does not contain undecomposed fragments of crystallized gypsum which could act as germs or nuclei and thus assist in the process of crystallization.

(To be continued).

REGULATING CEMENT BLOCK MAKING IN GRAND RAPIDS.

The Common Council of Grand Rapids, Mich., recently passed an ordinance regulating the making of cement blocks. We publish the following abstract of the ordinance for the benefit of our readers:

In the first place, no person can make cement blocks without first obtaining a license, which must be applied for direct to the Common Council, and pay a fee of \$10. A license is good for one year, from May 1, or if taken out after May 1, is good only till May 1 next, the licensee being taxed pro rata.

All blocks must be marked with the maker's name or brand, the date made, and the proportion of cement, sand and stone used.

The minimum weight of different blocks shall be as follows: 8x8x16, 53 pounds; 8x10x16, 65 pounds; 8x12x16, 78 pounds, and 9x10x24, 112 pounds.

Transverse Test—The modulus of rupture for concrete blocks at twenty-eight days must average 150, and must not fall below 100 in any case.

Compression Test—The ultimate compressive strength at twenty-eight days must average one thousand (1,000) pounds per square inch.

Absorption Test—The percentage of absorption (being the weight of water absorbed divided by the weight of the dry sample) must not average higher than 15 per cent.

The so-called two-piece or anchor blocks, continuous air space, shall weigh the same as other makes covering the same area, and all other sized blocks not mentioned in this ordinance shall weigh in the same ratio as the sizes herein mentioned.

Section 4.—The composition of said blocks shall be:

Cement, one part; sand and gravel, five parts.

The sand used shall be suitable siliceous material, passing the one-fourth inch mesh sieve; clean, gritty and free from impurities.

No gravel larger than will pass through a three-fourth inch mesh screen shall be used in cement blocks. Each maker must use his own good judgment as to the quantity of sand and gravel in the one and five parts mixture, so that there will be no voids in the cement blocks.

The barrel of cement shall weigh 380 pounds net, either in barrels or in cloth or paper bags. A cubic foot of cement shall be called not to exceed 100 pounds, or the equivalent of 3.8 cubic feet per barrel. Cement must be gauged or measured in the original package, and never loose in bulk.

When blocks are made of slush concrete in individual molds and allowed to harden undisturbed before removal, the proportions may be one part cement to not exceed three parts sand and five parts stone, but if the stone is omitted the proportion of sand shall not be increased.

Hand Mixing—The cement and sand in correct proportions must first be perfectly mixed dry; the water shall then be added carefully and slowly in proper proportions and thoroughly worked; the moistened gravel or broken stone shall then be added, either by uniformly spreading the same over the mortar or the mortar over the stone or gravel, and thoroughly worked until all the material is fully incorporated one with the other.

Machine Mixing—Machines must be of a design adapted to the particular work. The sand and cement, or the sand, cement and moistened stone, must first be thoroughly mixed before the addition of water. When making slush or wet concrete this procedure may be varied, with the consent of the Building Inspector.

Blocks must be tamped or otherwise suitably compressed, and after the surface is struck off it must be troweled or otherwise finished to secure density and a sharp and true arris.

Section 7—Every precaution shall be taken to prevent the drying out of the blocks during their initial set and first hardening. A sufficient quantity of water shall first be used in the mixing to perfect the crystallization of the cement, and, after molding, the blocks shall be carefully protected from wind currents, sunlight, dry heat or freezing for at least five (5) days, during which time additional moisture shall be applied by approved methods, and occasionally thereafter until ready for use.

Section 8—Hollow cement blocks in which the ratio of cement to sand be one-third (1-3 (one part cement to three parts sand) shall not be used in the construction of any public building until they have attained the age of not less than three (3) weeks.

Hollow cement blocks in which the ratio of cement to sand be one-half ($\frac{1}{2}$) (one part cement to two parts sand) may be used in construction at the age of two (2) weeks, with the special consent of the Building Inspector.

Special blocks of rich composition required for closures, may be used at the age of seven (7) days, with the special consent of the same authority.

The time herein named is conditional, however, upon maintaining proper conditions of exposure during the curing period.

Hollow cement blocks shall not be permitted in the construction of party walls, except when filled solid.

No hollow cement blocks shall be used in the construction of any building unless the maker of said blocks has submitted his product to the full test required herein and placed on file with the Building Inspector a certificate from a reliable testing laboratory

showing that representative samples have been tested and successfully passed all the requirements hereof, and giving in detail the results of the tests made.

No cement blocks shall be used in the construction of any building until they have been inspected and approved, or, if required, until representative samples be tested and found satisfactory. The results of all tests made, whether satisfactory or not, shall be placed on file in the office of the Building Inspector. The Building Inspector is empowered to visit all places where blocks or forms are made.

Failure to comply with the regulations entails revocation of the license. Violation of any of the provisions of the ordinance may be punished by a fine of not less than \$5 or more than \$100, or by imprisonment at hard labor for not less than one day or more than thirty days, or both fine and imprisonment may be imposed. In the event of a fine only being imposed, and a failure to pay it and the costs, the above term of imprisonment may be awarded until the fine is worked out or paid.

REPORT OF COMMITTEE ON WATERPROOFING TO THE AMERICAN SOCIETY FOR TESTING MATERIALS.

Sub-Committees "A" and "B" in charge, respectively, of waterproofing investigations, the former of methods through the treatment of mortars and concretes by the incorporation of foreign substances, non-bituminous in character, the latter of methods through the use of bituminous material applied directly to the surface to be treated, or through cloth or similar mediums, have both pursued the work outlined and reported as under way at the time of our last convention June, 1908.

Sub-Committee "A" has been unable to develop any lines of investigation materially differing from those determined upon, but the present year's tests results very generally corroborate the conclusion previously noted, with the additional positive information that with even such ungraded materials as crushed quartz or standard Ottawa sand, no difficulty is experienced in a laboratory, with its care in operating, in obtaining waterproof mortars in such lean proportions as 1 cement, 4 sand. There is no excuse for failure when a fairly graded natural sand is used with even leaner mortars, confirming the fact that the reason ordinary field concrete mixtures need water-proofing treatment is due either to the use of poor material or poor proportioning or bad handling, or cumulatively to all of these combined. We think it has been demonstrated and will be generally admitted that with proper materials, proper proportioning and proper handling of the subsequent mixtures, these need no additions of foreign substances to become initially waterproof; that when such addition is needed, for reasons above stated, the desired end can be and is most easily secured mechanically through proper void filling, compensating for the poor proportioning or the poor quality of the original constituents. Any chemical action claimed for mixtures operating towards securing waterproof concrete is apparently nil. Since void filling is to be sought as the panacea of waterproofing ordinary field concrete, comparative tests through the additions of percentages of colloidal clay or hydrated lime and the various advertised waterproofing compounds have been carried on continuously with the conclusion at this date that no general results are obtainable from

the additions of patented or proprietary compounds which cannot be obtained equally well through the use of colloidal or hydrated lime. Additionally, it seems to be very generally proved by corroborative tests, results of which will be submitted later when long-time results will be available, that, as stated in last year's report, to be likely a weakening in tensile strength in time allowed the use of many of the patented compounds, which effect is not generally marked when colloidal clay or hydrate lime is used. It has been concluded that the so-called patented compounds fail to remedy defectively proportioned concrete of poor materials as effectively and positively as colloidal clay or hydrated lime simply because they do not carry sufficient fine material called for by existing conditions. The apparently waterproofing effect of some of these proprietary compounds at early stages, with the very common loss of strength later on, only confirms the opinion as to their temporary effect being mechanical entirely, in aiding, through deposits, to fill voids to the desired end, which can be permanently better assured by the use of proper percentages of fine material such as colloidal clay or hydrated lime.

It was a more difficult proposition for Sub-Committee "B" to formulate test methods in the case of bituminous waterproofing material; for while the manufacturers of these have been solicited and requested to co-operate with the committee, since it was considered desirable that where so much depended upon the actual application of the material it was essential that these should be placed by the manufacturers themselves, in accordance with their practical methods; up to the present time only six manufacturers have appeared willing to enter into the committee's program. The committee does not pretend to say why all the manufacturers of such materials should not be willing to join it, but the fact remains that our experiments have been limited and unless resort was had to the purchase of such materials and placing of same under test by members of the committee apart from any action of the manufacturers themselves, the members of such materials under test must necessarily remain limited. Our experiments consisted of having built concrete tanks, 18 inches by 12 inches by 9 inches of 1 cement, 3 sand and 5 stone proportions, protected on the inside by each manufacturer with his own material according to his own approved method of application. The methods naturally varied somewhat in individual cases. The bottom and sides of all tanks under treatment were covered with a very lean cement mortar so as to prevent the waterproofing material's immediate contact with the various liquids with which the tanks were later filled. Five-sixteenth-inch (5/16-inch) holes were previously punched through the 3-inch bottoms of the tanks, as originally made and before treatment, so that the effect of the containing liquids, four separate ones being used in every case, might be more rapidly demonstrated by their appearance at the bottom of the tanks. The liquids used were:

First—Astoria gas drip.

Second—Seepage water from the sump of the New York Subway at Forty-second street, which surface water had apparently injuriously affected the bituminous waterproofing material of the original construction.

Third—This same seepage water with the addition of 5 per cent kerosene by volume.

Fourth—New York City water made alkaline by the addition of about 23 per cent potash.

After the filling of the tanks, they were regularly inspected, but as results are not complete to date, the attacking effects not being positive in all tanks, it is deemed advisable to withhold any results until complete comparison can be instituted.

The above is simply offered as a report of progress, and respectfully submitted on behalf of the committee.
W. A. Aiken, Chairman.

CEMENT PAINT FOR STEEL STRUCTURES.

F. E. Geisecke, professor of architecture and drawing of the Architectural and Mechanical College of Texas, has determined by a series of experiments that a coating of neat cement paint applied to structural steel before it is used in the construction of a building will prolong the life of the steel and will bring about a better adhesion than if other treatment is used.

Mr. Geisecke is a graduate of the Agricultural and Mechanical College of Texas. He is now the head of that department of instruction of the college and is the college architect, and all building at the college is under his supervision. During the last year he has supervised the new engineering building and the building for the Texas Experiment Station. In both of these a large amount of structural steel was used, and he made the experiments referred to on this account, and also in the nature of scientific research, says a writer in the Dallas News.

Mr. Geisecke says that in reinforced concrete construction, where small bars or rods are used, it is comparatively easy to cover the same with concrete, but when large beams are to be covered this is much more difficult, partly because it is difficult to make the concrete run so as to fill all cavities between the forms and the steel and partly because the larger beams are exposed to the weather for a considerable time before the concrete can be poured and are therefore apt to be partially covered with scales of rust, which prevent a contact between the concrete and the steel, and which may act as carriers for carbon dioxide and moisture, thus producing a continuation of the rusting process under the concrete coating. It is, therefore, desirable to coat the structural steel before it has begun to rust thoroughly with some material which prevents rusting and which has no injurious effect on the adhesion between the concrete and the steel.

On June 3 of sixteen steel rods three-eighths of an inch in diameter and about 18 inches long, four were painted with red lead, four with boiled linseed oil, four with neat Portland cement, and the remaining four were not treated. The painted rods were allowed to dry in the shade for one week and then each rod was placed in a cylindrical tin can so that one end projected about one inch through a hole in the center of the bottom. The cans were then filled with concrete of 1 to 3 and stored in a shaded place, where the concrete was allowed to set.

When the concrete was one week old one-half of the specimens were tested in an Olsen testing machine by pulling the steel rods. The adhesion was found to be, expressed in pounds per square inch: Oil coated rod 34, red lead coated rod 68, uncoated rod 136, cement-coated rod 170.

The remaining specimens were tested when the concrete was nine weeks old, and the following adhesion was found: Red lead coated 38, oilcoated rod 72, uncoated rod 170, cement coated rod 465.

It appeared from these tests that the adhesion between steel and concrete was materially increased by coating the steel with neat cement.

The test of the first four specimens showed that a coating of oil and one of red lead had very injurious effects upon the adhesion between the steel and the concrete. In this experiment, however, the red lead paint had been allowed to dry for only one week.

Mr. Geisecke, therefore, tried another test and on June 19 four rods were painted with red lead and allowed to dry for two months. On August 9 eight rods were painted with neat cement. Four of these were placed in the shade to set and four were exposed to the weather. On August 18 these twelve rods and four which had not been treated were imbedded in concrete as described above. When the concrete was one week old eight of the specimens were tested and the adhesion found as follows: Red lead coated rod 9 and 4, uncoated rod 160 and 190, cement coated in the shade 190 and 210, cement coated exposed to weather 160 and 390.

At one month old four specimens were tested as follows: Red lead coated 17, uncoated rod 220, cement coated rod in shade 410, cement coated exposed to weather 390.

At two months old three specimens were tested and the adhesion found: Uncoated rod 254, cement coated rod in shade 272, cement coated exposed to weather 305. The fourth rod, painted with the red lead, was damaged,

Mr. Geisecke deduces, first, that the adhesion in the case of the red lead coating is not increased by allowing a greater period of time for the drying of the paint; second, that the adhesion, in the case of cement coating, is not affected injuriously by exposing the coated steel to the weather. It was found that the best results can be obtained if the cement coating is moistened repeatedly for several days by either rain or dew or an artificial spray of water.

If the adhesion between concrete and uncoated steel is taken as a basis, it is evident: 1. That the best results can be obtained if the cement coating is red lead. 2. That the adhesion is reduced about 80 per cent by a coating of linseed oil. 3. That the adhesion is increased about 35 per cent by a coating of neat cement.

Mr. Geisecke estimates that for sizes and shapes commonly used and which represents average values, the cost would be about 63 cents per ton, a little less than 1 per cent the cost of structural material erected in the building.

COUNTRY HIGHWAY BRIDGES OF CONCRETE.

In connection with the improvement of country roads under the help of state officials, considerable attention is being paid to the substitution of concrete bridges for the dangerous timber bridges that are still far too numerous even on roads subjected to considerable travel. The usefulness of concrete for small structures is too self-evident to need discussion. The experience of recent years indicates, however, that they have a special danger of their own, and it is no small danger. The old days of country highway bridge construction, when the bidders for such structures formed a pool at every important letting, and the county paid an exorbitant

price for what was often a pretty poor bridge, have given way to a condition just as expensive and considerably more dangerous. Anybody who has put in concrete cellar floors or walls is considered a concrete specialist in his own bailiwick, and it is difficult to persuade all road commissioners that these local parties are not competent to design and build any bridge that may be needed on the roads in their vicinity.

It is notorious that one accident receives more attention than a hundred successes, and for this reason the troubles with concrete culverts and short bridges, particularly in the Central States, have undoubtedly been magnified far beyond all due proportion. The fact remains, however, that the road commissioners in many districts must be educated to a proper understanding of the peculiar requirements for successful construction in concrete. Their experience with steel structures has led them to consider that a bridge is necessarily something manufactured and erected under machine shop conditions. They do not appreciate that a concrete bridge is manufactured on the spot; that the raw materials are assembled and put in place under working conditions that are not so comfortable as those of an enclosed building, and that the class of labor employed is rarely skilled. They do not comprehend that strict supervision is necessary to insure the use of good materials in the proper way. Consequently they are inclined to let the contract to the lowest bidder and to permit him to carry on the work according to his own ideas, regarding or disregarding the plans as he sees fit. Under such conditions it is not surprising that a few concrete structures show defects; it is surprising that more do not.

When it comes to longer structures, a complication is immediately introduced that does not exist in the case of steel bridges. This is caused by various patents governing methods of reinforcing arches. Some people hold that these patents are not very strong, but in the absence of any judicial decision concerning them, many leading engineers believe, on the advice of their lawyers, that the best interests of their clients are served by acknowledging the validity of the patents. If the engineer for a road commission attempts to design such a bridge without utilizing any patented feature, he is likely to run his client into much expense. If he prepares his plans so as to use a single patented system, he is subjecting his clients to the danger of a taxpayer's suit in case the owners of some rival patent choose to stir up trouble. If he prepares general plans and specifications such that any patented system of construction can be used, leaving the bidders to select those they prefer, there is another legal danger in some states where it is necessary for complete plans and specifications to be placed on file for the use of bidders. These conditions have been discussed in a few local engineering societies, but they are acquiring a prominence in concrete bridge work which makes it desirable for a better agreement concerning them to be reached among engineers.

Where the engineer believes it best to design a structure without any regard to patents, the case is very simple. It is merely one of running the risk of patent litigation. But where the engineer is desirous of making use of patented methods of design and employing the experience of the owners of these patents, differences of opinion exist with regard to the best practice to follow. It is manifestly to the interest of the road commissioners in such a case to secure the widest possible bidding, and hence plans and specifications should be drawn so that all responsible systems of reinforcement may be employed. The owners of these systems maintain engineering organiza-

tions for the purpose of preparing promptly detailed plans according to these systems. Apparently, therefore, the work of the road engineer is to prepare general plans and specifications with enough elaboration to meet all legal requirements and yet leave the design of the details to the engineers of the companies owning these patents. This is, in substance, adopting the procedure followed with many so-called standard specifications for steel highway bridges. The engineer using such specifications does not detail the structures, but leaves that work for the bidders. The only difference between this practice and that suggested for reinforced concrete spans is that, in the case of the latter, the bidders add ten per cent. to the estimated cost of the work as a royalty to the owners of the patents. If the validity of the latter is to be recognized, such a system seems to be the most economical and likely to produce the best structure, provided the engineer who examines the detailed plans of the various bidders is competent to determine whether they are suitable for the given conditions. It is possible, of course, that some better arrangement may be devised, for work of this sort is in its infancy in this country, and patent litigation may arise with results entirely changing the conditions.

Wichita, Kan.—A new \$12,000 concrete dam will be built 200 feet down stream from the old Sullivan's dam on the Little river. The city commission at their meeting yesterday instructed the city clerk to advertise for bids on the work.

* * *

Shortsville, N. Y.—Henry H. Hebbard, who has been experimenting with materials in order to find a substitute for marble in making monuments, has discovered a process of combining cement and marble which promises to be a valuable find.

He has just completed a stone made of this combination, which is as white as the whitest marble, and which he states will withstand time and weather. Its surface is perfectly smooth and in looks it differs from marble only that it has not the high polish that a new marble shows. One of the strong points of Mr. Hebbard's monument is the clearness of the lettering which can be read at a great distance. He places the inscription on a piece of plate glass, which is imbedded in the stone.

Mr. Hebbard has applied for a patent on his discovery, and will soon engage in the business of manufacturing these monuments, which can be made in any design for which marble is used.

* * *

Jas. and S. Montgomery will install a cement tile and block factory at Brewster, Minn., to be known as the Brewster Cement Works. Newest machinery of the latest type will be put in.

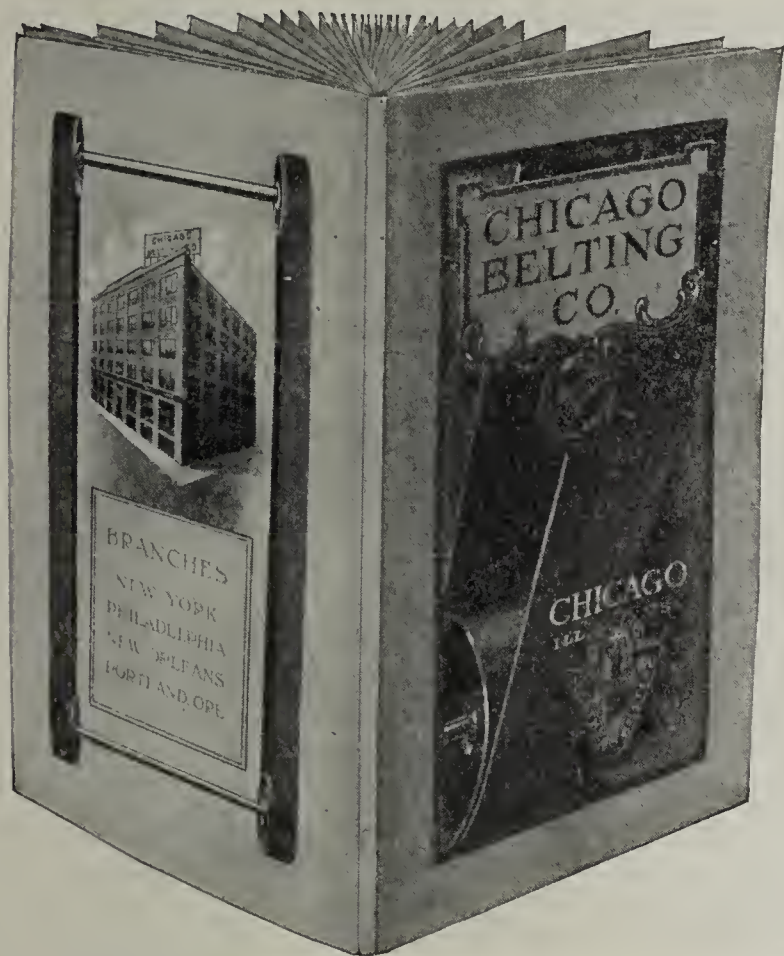
H. M. Rauscher, D. O. Friend and W. H. Lloyd have under consideration the erection of a plant at Brighton, Iowa, to manufacture cement tile and building blocks. It will cost about \$10,000.

* * *

Plans for the construction of a system of mechanical filters, re-inforced settling basins, etc., for the Board of Public Service of East Liverpool, O., are being revised by the engineers, John W. Hill & Sons, 506 First National Bank Building, Cincinnati, O. Bids were taken several weeks ago on this work, but were considered excessive and were rejected. If possible a contract will be let and actual work started this year.

NEW CATALOGUE OF CHICAGO BELTING COMPANY.

The Chicago Belting Co., the manufacturers of the well-known "Reliance Brand" and "Sea-Lion Waterproof Belting," have issued a new catalogue describing in detail every phase of the process of manufacture of their belts. The pamphlet, which is ready for distribution among owners of factories and other parties desiring information about belting, is profusely illustrated and thus affords a good insight into the method of producing these belts as well as into their wide application. The "Reliance Brand" is one of the highest grades of belts and is found in common use at large factories such as cement plants, ore-mills and so forth, while the "Sea-Lion Waterproof Belt" is especially adapted for use in a moist atmosphere, as for instance in damp climates or at establishments where the air is highly saturated with moisture or



Chicago Belting Company's New Catalog.

steam. A number of other brands, namely the "Sterling," "Imperial" and "Dynamo" brands, are intended for lighter machinery and are found to be very serviceable for the purposes for which they are made.

Various chapters are devoted to the proper application of belts and to the best methods of preserving and repairing them. In addition to these, the proper tools are described for punching, cutting and lacing belts, so that every one looking for information on belts, by careful perusal of this literature, will be enabled to give his belts the best of care.

As high grade belting is one of the most important factors at every plant and as the smooth and uninterrupted running of the machinery depends, in a great measure, upon the care taken of the belt, this new instructive guide will be found to be a valuable contribution to the technical library of every buyer and user of leather belts.

STEEL CENTERING.

The Readjustable Steel Centering Company, Fond du Lac, Wis., are manufacturers of monolithic concrete sewer and culvert centers which makes this work much easier and what is more to the point much cheaper than any other construction. We need not go into details as to the relative merits of concrete in comparison with other methods of sewer laying, as it is a well established fact that concrete sewers are by long odds the best sewer that can be made. The reasons are obvious. In the first place brick sewers are constantly in need of repairs, as are brick culverts; consequently, their up-keep is very expensive. But where concrete has been laid, either in sewer or culverts, it is there not only for the present generation, but for succeeding generations. St. Joseph, Mo., for instance, comparatively recently has been laying nothing but concrete sewers. At first they used wooden forms, but after trying steel centers their success was so great that now nothing else is used. St. Joseph is one of the most progressive cities in the United States, and their city authorities looked into the matter very thoroughly before deciding to use them. The method used by the Adjustable Steel Centering Company is extremely simple, as their forms are made collapsible, and instead of having to have them lifted out of the sewer and carried forward they are pulled through the sewer to their correct position. Along the bottom of each form are two little skidways upon which the form is moved. These centers are adapted for all shapes and sizes of sewers, culverts, conduits, ducts, sub-waste pipes, drains, arches, cisterns, etc. They can be bought in almost any diameter or length. They have proven their worth in innumerable instances for the following reasons:

First and foremost, they are collapsible.

This will appeal to any contractor, inasmuch as they can be removed without their marring the interior surface of the sewer; consequently it makes a better sewer than the wooden form, as it leaves the interior as smooth as glass, where if a wooden form is used the interior is naturally rough.

Their guaranteed strength gives an absolutely uniform shape to the finished work.

When the forms collapse they come from the concrete very easily, with absolutely no shock; consequently, there is an insignificant strain on the structure.

By the use of the forms more rapid construction, by far, is easily attained.

Work can be executed in the winter time.

Being adjustable they may be used in various diameters of work.

Their literature explains their methods very thoroughly. This will be gladly sent upon request.

The Anchor Stone Co., of Minneapolis, Minn., has begun on a building they will erect at 2937 Lyndale av. S. It will be 40x113, 3-story. The foundation is complete and work is begun on the super-structure. They will use their hollow cement block in the construction. This will be used for their new manufacturing plant for their hollow cement blocks and laundry tray. Cost \$7,000.

The Louisville Cement Co. have closed down their plant at Speeds, Ind., for repairs.

METHODS AND COST OF CONSTRUCTING A CONCRETE SEWER IN FREEZING WEATHER.

Adjustable Steel Centering Company's molds were used:

The work consisted of a sewer 1,360 ft. long and 30 ins. in diameter, with a 4-in. shell constructed during November and December, 1908, with the thermometer ranging 14 degrees above zero to above freezing point. The necessity of using frost preventives added about 2½ cts. per lin. ft. to the cost of the work. The following is a description of the sewer and its construction. The location of the work was at Fond du Lac, Wis.

About four years ago the city dug an open drain along a highway upon the outskirts of the city for

and 30 ins. inside diameter, with 4-in. walls; it contained, therefore, about 1/9 cu. yd. of concrete per lineal foot. In addition there were 17 cu. yds. of concrete in the two abutments or portals at the ends of the sewer.

The itemized total cost of the sewer was as follows:

Items—	Total.	Per. Lin. Ft.
Labor	\$ 635.50	46.72 cts.
Tools	24.59	1.81 "
Sandy gravel	208.40	15.32 "
Lumber	14.04	1.03 "
Water	11.35	0.83 "
Frost preventives	34.38	2.53 "
Cement	370.19	27.22 "
Steel forms	204.35	15.02 "
Engineering	132.00	9.71 "

Totals \$1,634.80 \$117.19



View Showing Adjustable Steel Centers Used in Constructing the Sewer.

carrying stormwater into DeNeveu creek. On account of the ditch washing into the road it was decided to place a pipe in this trench and backfill over it. Accordingly the city engineer drew plans and specifications for receiving bids on three kinds of construction: (1) monolithic concrete with 4-in. walls; (2) double strength vitrified pipe, and (3) Jackson concrete pipe. The lowest figures among six competitive bidders were per lineal foot for Jackson pipe \$2.50, for vitrified pipe \$2.10, and for monolithic concrete \$1.245. The contract was awarded to Burret & Dooley for the monolithic concrete sewer. The contract was awarded on Nov. 10, and a few days later work was begun. Owing to the lateness of the season the city officials were concerned at first about the hazard from freezing weather, but they were convinced of its unimportance by the means planned by the contractors to prevent frost damages. These means proved wholly successful, as is described later.

The sewer, as before indicated, was 1,360 ft. long

In this statement the labor item is for unskilled laborers at \$2 per day, working from 3 to 14 men a day for 29 days and 2 foremen at \$3 each for 31 days. The cost items for tools, lumber and frost preventives are the differences between their purchase prices and what they fetched when afterwards sold. The sandy gravel was purchased delivered from three different pits at \$1.50 per load of about 1.75 cu. yds., with some at 10 cts. extra per load; it cost, therefore, about 89 cts. per cu. yd. The gravel was mixed to obtain the greatest density of aggregates, and 5 parts of gravel were mixed with 1 part cement to make the concrete. The cement cost \$1.70 per barrel delivered in sacks, less the rebate on sacks returned. Water cost for hauling only, 35 cts. per load. The lumber was used for abutment forms and for establishing grades. The frost preventives consisted of horse stable manure, marsh hay, and a thin layer of flax straw sewed between two sheets of rosin paper and also fuel for heating the concrete materials. The steel forms were rented and

the cost includes drayage to and from the job and a small sum for oil to grease them. The charge for engineering covers the entire expense to the city and township for plans, specifications, advertising, inspection of sewer during construction, etc.

Separating the abutments containing 17 cu. yds. of concrete the cost was as follows:

Items—	Total	Per Cu.Yd.
Labor	\$25.50	\$ 1.50
Tools	00.59	0.035
Gravel	15.00	0.882
Cement	32.01	1.882
Lumber	40.04	0.237
Water	00.60	0.035
Frost preventives	1.88	0.110
Centers	0.75	0.045
Engineering, etc.	5.00	0.295
Totals	\$121.37	\$5.021

Some of these items are actual amounts and others are close approximations. The costs for the sewer proper arrived at in the same manner were as follows.

Items—	Total.	Per Lin.Ft.	Per Cu.Yd.
Labor on concrete	\$ 253.00	\$0.187	\$ 1.683
Labor excavation	357.00	0.263	2.367
Tools	24.00	0.017	0.153
Gravel	193.40	0.142	1.278
Lumber	10.00	0.007	0.063
Water	10.70	0.008	0.072
Frost preventives	32.50	0.024	0.216
Cement	338.18	0.249	2.241
Center molds.....	203.60	0.149	1.341
Engineering	127.00	0.093	0.837
Totals	\$1,549.43	\$1.139	\$10.251

In the above table the amount for the concrete labor includes the labor cost for heating the materials, mixing, and depositing the same in position complete, also for the small expense of operating the steel forms. The rest of the labor expense was for excavating the trench an average depth of 3 ft. and for back filling. This was done, as noted previously, in an old ditch, the bottom of which was red clay soil, requiring but a slight expense for trench bracing. No water ran into the trench except on a couple of days it rained when the water ran out soon through the molds into the sewer, as shown in the accompanying illustration made direct from the photograph of the work.

Flax straw, bound in paper already put up, was tried as a cover to the fresh concrete pipe, to keep frost away while the cement was setting, but the vapor from the concrete softened the paper cover so that it could not be handled and the article had to be discarded. The horse stable bedding of straw proved to be efficient for keeping frost out of the green concrete, it generating a certain amount of heat and allowed the moisture to pass through it from the heated concrete. Due to the chemical changes going on in this cover, too strong an article should not be laid next to fresh concrete, as in some places on the pipe it was observed that the cement did not set good for a depth of 1/16 to 1/8 in. A thin layer of marsh hay was placed between the manure and the concrete on the balance of the work and the condition did not appear again.

In the steel forms lighted oil heaters were placed at short intervals to keep up summer conditions while the cement made its initial set.

The style of the centers used was the full circle form so that the crown and invert of the pipe were built in one operation. The materials were mixed on a flat No. 12 gage steel sheet, size 60x156 ins. Concrete was put in the bottom of the trench first, which was dug somewhat rounding, and graded 4 ins. thick. Strips of No. 26 gage sheet steel 12 ins. wide by 8 ft. long, previously rolled to the arc of 30-in. circle, was next laid, one piece lengthwise on this bed, then one 5-ft. section of steel forms was placed upon the strip, or track. The form was expanded to size by turning the hand wheel, shown in the cut to the right, the correct diameter being obtained by fitting a wire hoop gauge around the near end of the center and expanding the center against the gauge. Another batch of concrete now ready was positioned around the form, and operator at the front end of the form having a steel blade, 5 ins. wide by 10 ins. long, affixed to a long handle, tamped the concrete firmly to place under the two bottom quarters of the form so that the possibility of voids or pockets forming in the bottom of the concrete pipe to be refinished later, was eliminated, the concrete being positioned on top of the form nearly out to the end. Another form being set, the process described was repeated until all the forms used on the work was concreted.

The object of using a light steel track, or slide, under the forms was so that the molds could be drawn out easily the next morning one at a time, and to prevent scraping out with them partially set concrete from the bottom of the sewer, the steel track being laid with lapped ends so that the forms could slide over the joints and not disturb the track. The track was, of course, taken each morning from the sewer after the centers were withdrawn and used repeatedly.

Collapsing of the centers was accomplished by merely giving the hand wheel a few turns to the left, when the mold was pulled out of the sewer with a rope and taken ahead in the trench for resetting when needed. No bracing of the forms was required to keep them in alignment. The top of the concrete pipe was shaped with a wood hand float, the concrete for this purpose not being made wet enough to make it sloppy.

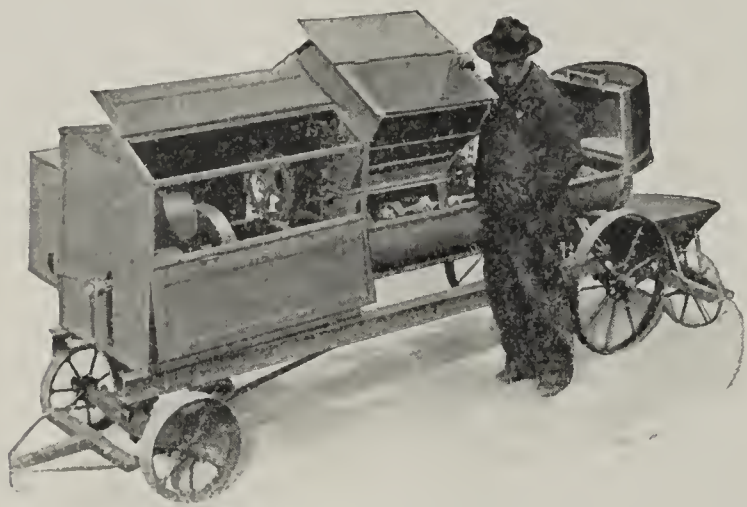
The adjustable steel centers as used on this job were handled upon the desirable unit plan; however, all the forms may be set before placing concrete about them, or in any other way that may appeal to a contractor as most advantageous. Two Y-connections were made to this sewer by placing the small ends of clay pipes against the steel forms as the concrete was being positioned. The next morning when the steel forms had been removed the first connection had some concrete to be broken out of the end and refinished while the one made later was found perfect. Gas engine oil thinned with kerosene and applied with a brush to the surface of the molds prevented the adhesion of concrete to the forms. The temperature varied during construction when concrete was made from 15° above zero to above the freezing point. The thermometer one morning registered 12° below zero, but by 10 o'clock it showed 15° above when concreting was started. One foreman with a crew of six men often put in 70 ft. of sewer in less than 5 hours' time.

The style of mold used on this job is manufactured by the Adjustable Steel Centering Co. of Fond du Lac, Wis.

MIRACLE POSITIVE FEED CONTINUOUS MIXER.

A concrete plant equipped with a modern mixer was an exception a few years ago. Today, the conditions are reversed and the plant without a mixer of some kind is the exception. It takes but little reasoning to convince any business man that a device, which will produce 25 to 50 per cent more efficient concrete and a saving of 40 to 60 per cent, on mixing cost is a good thing to have.

The Miracle Pressed Stone Company of Minneapolis, Minn., have spent many thousands of dollars and much time in the development of their Miracle Positive Feed Continuous Mixer, and the 1910 model with all their latest improvements is now ready for the market. So large an inquiry has been received by the Miracle Company for this machine, that a special catalogue devoted to their Positive Feed Continuous Mixer has just been issued. This catalogue furnishes



Miracle Continuous Mixer.

some very interesting data on the subject of machine mixed concrete in general, and on the subject of mixing the same by the use of the Miracle Mixer in particular, and should be in the hands of all concrete workers.

We will not attempt here a technical description of the machine, but show herewith a view of this mixer, mounted on trucks with gasoline engine, ready for either street or shop work. It is all that the name implies, in that it is equipped with an absolutely positive feed device. This feature of the machine contains many new and interesting developments and is certainly worthy of your investigation.

The following letter received by the Miracle Company indicates what one Iowa customer thinks of the machine.

INTERSTATE DRAINAGE AND INVESTMENT COMPANY.

Successors to E. O. Rood & Son.,

Contractors for Drainage Swamp and Overflowed Lands.

Manufacturers of Drain Tile.

Makers and Operator of Rood's Ditchers.

Britt, Iowa, Jan. 6, 1910.

Miracle Pressed Stone Co.,

Minneapolis, Minn.

Gentlemen:—

You will doubtless be very glad to know that we are just as pleased as ever with the continuous mixer which we bought from you in 1909. We have used it continuously for about four months, and at a recent test made of a great many different makes of large cement tile, one of the parties making tests

made the remark that our tile, which were made from material run through your mixer, were the best cement tile they had examined. This remark in a brief way, combined with the fact that the tile in question stood a far greater test than the requirements, shows that the material, aside from being good, must have been thoroughly mixed and correctly measured.

In the manufacture of cement tile you will understand that the quantity to be handled in a given time is determined not so much by the capacity of the mixer, as the ability to take care of the tile, and place them where they are to be cured. We are able to handle only about 300 feet of 30 or 32 inch tile in a day's run and for that reason we have never had occasion to run the mixer to its full capacity. Another factor which prevents the run of the mixer to its full capacity is the inability of the tile making machine to handle much more than 300 feet of large tile a day, consequently we would not hesitate to recommend your Continuous Mixer to any one engaged in that line of business, and we will take pleasure in showing the machine in operation to any persons who are interested.

Yours very truly,

Interstate Drainage & Investment Co.,

By Jas. E. Verrall, Sec'y.

CEMENT MILL NEWS.

In accordance with an order from the circuit court of Noble county the Provident Trust company of Columbia City, Ind., will sell all the real estate and personal property of the Art Portland cement company, located in the village of Kimmell in Noble county, at the office of the trust company on Feb. 14. The sale will also include the secret for the manufacture of White Portland Cement.

About 500 acres of land will be included in the sale as well as the buildings, machinery, fixtures, stock, tools and property belonging to the company.

The sale will be made free from all liens upon the property except the taxes of 1909, due and payable in 1910 and undisputed possession of the property will be given on day of sale to the purchaser. The sale is to be made for cash.

* * *

Hudson, N. Y.—Fire destroyed the big storehouse of the Atlas Cement Company, causing a loss of about \$80,000. About \$20,000 loss was also caused in the cement mill adjoining. One workman is believed to have been burned to death.

* * *

The Allentown Portland Cement Company, of Evansville, Pa., will start their new plant by March 1. The capacity will be 3,000 barrels per day.

* * *

It has been reported that the Neodesha, Kans., plant of the United Kansas Portland Cement Co., will be reconstructed and equipped for a capacity of 3,000 barrels, daily.

* * *

Joseph First, and his brother, George First, of Louisville, Ky., have gone to Tulo, Mexico, to take charge of the construction of the cement plant of the Toltec Portland Cement Company, of Arizona, which is being constructed at Tulo, about fifty miles from Mexico City. The plant will manufacture Portland cement and will have a capacity of between 300 and

400 barrels of cement daily. The Messrs. First were selected by W. E. Burke, formerly connected with the Louisville Water Company, and now vice president and general manager of the company.

* * *

The Omega Portland Cement Co., of Louisville, Mich., have shut down for the winter months for repairs.

* * *

Brigham City, Utah.—The Ogden Portland Cement company began burning cement this week. The manufacturing of a high grade of cement from the waste barrens north of this city has actually commenced. People in this vicinity little dreamed of the value of those waste barrens, which for these many years have lain idle. And it wasn't until very recently that the marl and other valuable deposits found there were given consideration. The plant will have a daily capacity of 500 barrels of cement.

* * *

U. S. Consul Edwin H. Gunsaulus, at Johannesburg, South Africa, describes in the following manner the founding and building up of a cement factory in that country:

One of the most successful of the new industries established in the Transvaal is the Pretoria Portland Cement Works near Pretoria, where the daily production is about 60 tons of cement, said to be equal to the best imported article. Years before the war steps were taken by the Boer government to encourage the manufacture of cement, because of the large quantities imported for mine construction and other purposes. A subsidy of \$5 per cask for every lot of Portland cement manufactured locally was granted, but owing to the inferior quality of the local product in the beginning, the interruption occasioned by the war, and other difficulties subsequently encountered in the matter of securing the proper proportions of ingredients to insure a good product, the industry languished and was on the verge of dissolution when the present manager, E. Davidson, was brought here from Cleveland, Ohio, some five years ago to assume charge of the plant.

Under Mr. Davidson's management the factory was rebuilt, new machinery installed, and the works restarted along strictly scientific lines. Within the last year all difficulties in the way of turning out a first-class product have been overcome and the demand has been much greater than the supply. To meet the present and future demand the plant is being greatly enlarged, and when the improvements now under way are completed the output will be equal to 30,000 barrels per month, with power to materially increase this supply if necessary.

The monthly consumption of Portland cement in the Transvaal is now nearly 30,000 casks, and of this amount nearly one-half is supplied by the Pretoria works, the balance being imported. The new method of building by the employment of reinforced concrete is bound to bring about a greatly increased demand for cement, and it is now predicted that next year the Rand alone will consume nearly 500,000 casks of this product.

At present the duty on imported cement is 1 shilling (24 cents) per cask (400 pounds) from Great Britain

and 1 shilling 3 pence (30 cents) from other countries. The local product sells for 3 shillings (73 cents) less per cask than the best imported article. At present the Pretoria works can not meet the prices of the foreign product at the coast points of South Africa on account of the high railway rates. This may, however, be overcome in time.

In connection with the construction and rehabilitation of the Pretoria cement plant it is of interest to note that practically all of the machinery employed is of American design and manufacture. With the exception of two ball mills imported from Germany, all of the burning and grinding machines were imported from the United States, as well as the engines and electrical machinery.

* * *

At a meeting of the stockholders of the Alpha Portland Cement Company, at Alpha, N. J., on Jan. 20, it was voted to merge that company and the Cement Manufacturing Company, recently formed to take over a portion of the property of the Alpha company, its stock being distributed to the stockholders of the latter as a property dividend. Under the terms of the merger there will be issued to the stockholders of the two companies \$2,000,000 of 7 per cent cumulative preferred stock and \$8,000,000 of common stock. The consolidated company will take the name of Alpha Portland Cement Company. This increase in the capital stock is in the nature of a distribution of profits, as the directors have never authorized large dividends, but have put profits into the extension of the business. The first plant was built at Alpha, where Mills 1 and 2 are now located. Mills 3 and 4 are at Martin's Creek. Last spring the company bought and has since rebuilt the Buckhorn mill at Manheim, W. Va., and more recently it bought the Catskill mill at Cementon, N. Y. It is planned to increase the production of the mills very largely during the present year if business conditions warrant the step. The company's headquarters are at Easton, Pa.; Mr. A. F. Gerstell is president, Mr. J. M. Lockhart, vice-president, and Mr. G. S. Brown, secretary and treasurer.

* * *

The new cement plant at Des Moines, Iowa, built by the Hunt engineering Company of Iola, Kansas, and known as the Iowa Portland Cement Company, has a feature which should prove to be of extraordinary interest to cement manufacturers. To the writer's knowledge, this is the first instance in which concrete has been used for kiln chimneys, although it has repeatedly been used for power plant chimneys in connection with cement plants.

At this plant the kilns, 8 in number, $7\frac{1}{2} \times 125$ feet, are placed in units of two, each unit being served by one chimney, making four in all. The chimneys are 125 feet high above grade, with an internal diameter of 9 feet at the top, supported on foundations 30 feet square. It was necessary to spread the foundations in this case to 30 feet square, owing to soil conditions. The foundation desired is that of a slab 2 feet thick, topped with a truncated pyramid 2 feet high, the base of which is 30 feet square and the top of which circumscribes the base of the chimney proper 12 feet, 11 inches square. This foundation slab is re-inforced by a rectangular mesh and diagonal of $3\frac{3}{4}$ -inch square cold twisted steel bars in both directions.

John Delduca filed suit in the district court against the Colorado Portland Cement company for the sum of \$5000 for personal injuries alleged to have been received while employed at the rock crusher of the company at Portland. The plaintiff alleges that he was engaged in dumping ore cars into the mouth of the crusher and that the crusher became clogged. To remedy the condition it was necessary to reach beneath the cars and the plaintiff alleges that while his hand was upon the rail the cars moved. His first and little fingers were crushed off and the hand maimed so badly that he claims he will be unable to perform his customary work.

He alleges that the company employed an incompetent person to take charge of the moving of the cars and that a defective system warning when cars were moved was used.

TRADE NOTES.

The Sandusky Portland Cement Co., of Sandusky, O., reports its Pure White Stainless Portland Cement used on the following important jobs:

Hospital, Ellis Island, N. Y.
 Emigrants Bank, New York City.
 National Museum, Washington, D. C.
 Alfred Washington's Residence, Glencoe, Ill.
 Providence Hospital, Seattle, Wash.
 Soulard Public Baths, St. Louis, Mo.
 Mrs. Robt. Stafford's Estate, Huntington, L. I.
 H. R. H. Prince of Wales' Racquette Court at Marlborough House.
 Lurline Baths, San Francisco, Cal.
 O. C. Barber's Estate, Barberton, O.
 Their Medusa Waterproof Compound used in the following:
 Naval Y. M. C. A. basement and swimming pool, Norfolk, Va.
 Ranier-Grand Hotel extension basements, Seattle, Wash.
 Butler Bldg., San Francisco, Cal., basements 80' below sea level.
 Western Union Newspaper Bldg., Chicago, Ill.
 Swimming Pool, University of Minnesota, Minneapolis, Minn.
 Large building, 31st St. & 5th Ave., New York, being waterproofed by the Hedden Construction Co.
 Soulard Public Baths, St. Louis, Mo.
 Gary Light, Heat & Water Co., Power Bldg., Gary, Ind.

* * *

Pastle & Mahler, architects, 1732 Marquette Bldg., Chicago, Ill., awarded the general contract for the \$100,000 re-enforced concrete Healy Bldg., Woodward Ave., Detroit, Mich., to The Carey Construction Company Co., Contracting Engineers, 209-211 Lennox Bldg., Cleveland, Ohio.

* * *

The Sawyer Belting Company, of Cleveland, Ohio, reproduce in the January issue of their monthly bulletin two other "cuts" taken at the Castalia Portland Cement Company's plant which demonstrate further the varying and diversified service, successfully fulfilled by Sawyer Belting.

One cut illustrates the complex conditions that oftentimes are found in the "wet-room" of cement plants. Here where it is alternately hot, cold, wet and dry conditions which affect greatly the wearing qualities and life of machinery as well as belting,

Sawyer stitched canvas belts have been found most satisfactory.

The other half tone illustrates a Sawyer belt main drive installation, 92½ feet, 34 inches twelve ply, transmits power to the main line shaft from a 250 horse power engine and is one of two installed in this plant. These belts operate under extremely dusty conditions, and until "Sawyer Belts" were installed they had had trouble in obtaining satisfactory belting for this purpose in this department.

* * *

W. J. Rosebery, Jr., well known to users of concrete mixers throughout a large part of the country, has severed his connection with the Chain Belt Company of Milwaukee and has formed the Milwaukee Concrete Mixer and Machinery Company, of which he is vice-president and secretary. This company will market a new machine, to be known as the Milwaukee concrete mixer, which has recently been patented after Mr. Rosebery's designs, and which is expected to be ready for exhibition during the Chicago cement show. Mr. Rosebery not only knows what a good mixer ought to be, but he is so familiar with the market for concrete machinery that his connection with the new company ought to assure it success. The other officers are R. J. Schwab, president; H. E. Schwab, treasurer, and S. E. Shafer, chief engineer.

* * *

Chalmers & Williams, Chicago, Ill., have recently closed orders for Kennedy Gyrotory crushers with the following people:

One No. 10 for the North River Stone Co., Roundout, N. Y.
 One No. 4 for the Tularosa Copper Co., Bent, New Mexico.
 One No. 6 for Arthur McMullen, Rome, New York.

NEW CEMENT PLANTS.

A committee has been appointed by the directors of the United States Portland Cement company, Denver, Colo., to make arrangements for doubling the capacity of the plant at Portland, Fremont county, near Florence. About \$250,000 will be expended in the work.

This company is incorporated for \$800,000, and when the present plant was built provisions were made for doubling at some future date. Adolph Coors, H. W. Humphries, C. P. Allen, W. H. Kelso and J. D. Blunt were re-elected directors.

* * *

The United States Steel Corporation has authorized the expenditure of \$2,450,000 by one of its subsidiaries, the Universal Portland Cement Company, in the construction of Cement Plant No. 6 at Buffington, Indiana, to have a capacity of 2,000,000 barrels of Universal Portland Cement per annum.

This plant will be located alongside of Plants Nos. 2 and 4 of the Universal Portland Cement Co., which have been in operation for some years. It will be so designed as to be easily extended to its ultimate capacity of 4,000,000 barrels per annum without interference with operations.

This plant will be operated entirely by electric motors, the power being transmitted five miles from the Power Station at Gary, Indiana, containing gas engines utilizing waste gases from the blast furnaces.

With the extension of Cement Plant No. 5 at Universal, Pa. (near Pittsburgh) just now being complet-

ed, increasing the capacity of that plant from 1,500,000 to 3,500,000 barrels per annum, this additional plant at Buffington, when in operation at the beginning of 1911, will give the Universal Portland Cement Co., a total output of 10,000,000 barrels per annum of Universal Portland Cement, all manufactured from blast furnace slag and limestone.

The output of Universal Portland Cement each year since it was first manufactured in 1900 is as follows:

1900	32,443 barrels
1901	164,316
1902	318,710
1903	462,930
1904	473,294
1905	1,735,343
1906	2,076,000
1907	2,129,000
1908	4,535,000
1909	5,786,000
1910 (est)	8,000,000
1911 (est)	10,000,000

* * *

The Peoples' Portland Cement Company recently organized to build a plant in Spokane, Wash., have opened offices in the Great Northern Building, Chicago. No engineer has been elected as yet, but one will be engaged this month. The plant will have three kilns.

* * *

Castleberry, Ala.—Dr. Perry L. Hobbs, 2047 East 9th street, Cleveland, O., will erect a Portland Cement plant, in this city, in the near future according to press reports.

* * *

The Blaim Banking House, Wall Street, New York, N. Y., have organized a company, for the purpose of erecting a cement mill in Tennessee. John A. Miller of Nazareth, Pa., president.

* * *

Topeka, Kans.—The state charter board granted a charter yesterday to a \$750,000 Portland Cement company. The company has been organized at Arkansas City and is known as the Arkansas City Portland Cement company. The capital stock amounts to three-quarters of a million dollars. The company proposes to establish a cement plant in Crowley county and manufacture and sell cement and cement products. Arkansas City has natural gas and the cheap fuel is responsible for the establishment of the plant at that point.

The incorporators of the company are: Vanton O. Foulk, W. H. Hume and F. Trumper of Arkansas City, S. J. Gilbert of Joplin, George H. Parker of Wichita and V. E. Creighton of Arkansas City.

* * *

Hudson, N. Y.—Draftsmen are busy in the office of the Knickerbocker Cement Co. preparing plans for the big plant the company proposes to erect in the spring near Fountain Head.

* * *

Kingsport, Tenn.—Plans are being completed for a \$500,000 cement plant to be established here. Mark W. Potter, and others, of Johnson City, Tenn., are the promoters.

* * *

F. R. Clark, of Spokane, representing Spokane and Eastern capitalists, has purchased the cement property of the old Pacific Cement company, at Cement, Stev-

ens Co., Washington. It is stated that a plant with a capacity for manufacturing 2,000 barrels of cement a day and employing 300 men will be started at once.

* * *

The Mobile Portland Cement Co., Mobile, Ala., will soon start construction work on their new plant. Dr. O. Gerlach, Van Antwerp Building, Mobile, Ala., is making the plans.

* * *

Reports state that the Dakota Portland Cement Company, offices Sioux Falls, S. Dak., will begin work in the early spring on their new cement plant at Chamberlin, S. Dak. It will have a capacity of 2,000 barrels per day. Osborn Engineering Company of Cleveland, O., are the engineers.

* * *

Contracts were recorded in San Bernardino, California, by the Arrowhead Portland Cement Company, for the erection of a 1,000-barrel per day mill, to be located at Etiwanda, San Bernardino county. Smith, Emery & Co., chemical engineers, of San Francisco, will have entire charge of the work, and it is proposed to have the plant finished and in operation inside of twelve months. The cost of the mill and equipment will be about \$700,000.

* * *

The Toltec Portland Cement Company, office, Kansas City, Mo., have ordered from the Allis-Chalmers Company the following induction motors and equipment for its plant at Hidalgo, Mex.: Five 150 h. p. motors of special design for driving tube mills, two 150 h. p. motors to be belted to line shafts, two 110 h. p. motors and one complete 20 h. p. single drum hoist.

* * *

Robinson Cement Tile & Concrete Company, Robinson, Ill.; \$15,000; manufacturing and selling cement concrete products and dealing in building material generally; H. H. Parker, H. L. Mefford, A. W. Root.

CEMENT WALKS ON FARMS.

Cement walks on farms are becoming quite common in some of the communities. They are easily made and are everlasting if made right. A good many farmers are doing without them because of the expense. If the sand is hauled at odd times and the walk put down in sections as the time can be spared, the expense will not be felt, because the cost of materials in the country is not very great, and then it is a great satisfaction to have good walks.

If the subsoil is porous and allows the water to fall away rapidly so as to prevent freezing, it is not necessary to excavate for a foundation, as the walk will not settle. But where the subsoil is a stiff clay it is better to excavate from 14 to 16 inches and fill to within 4½ inches with cinders or gravel to make a firm foundation. Two-by-fours are used for the sides of the form, taking great care to level them.

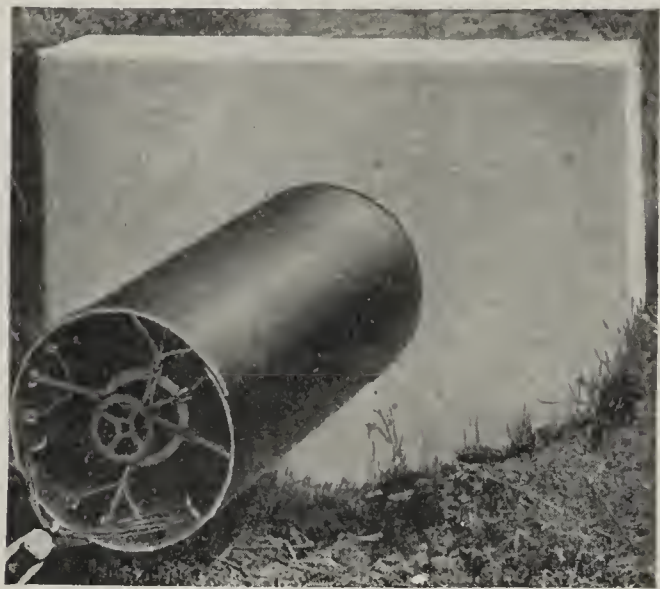
The surface coating is composed of one part cement and two and one-half parts of sand mixed to the consistency of mortar and spread over the concrete forms and smoothed with a trowel. Cover the walk to protect it from the sun and it will be ready for use in three days, but will not get its ultimate strength before thirty days.

MIRACLE COLLAPSIBLE STEEL FORMS.

The Miracle Pressed Stone Co., of Minneapolis, Minn., have just issued a 24 page booklet covering the subject of Collapsible Steel Forms for building sewers, culverts and conduits.

The Miracle Collapsible Steel Forms have been in general use for the past three years and that they are practical and give the best of satisfaction is certainly attested by their many customers, who are quoted in this booklet.

The booklet shows the multiplicity of uses to which the forms can be applied, as well as their practicality, simplicity and ease of handling. A number of beautiful specimens of concrete culverts are shown as well as the comparative cost of different materials for the building of culverts. Examples are given of con-



Miracle Collapsible Steel Form.

crete replacing small wooden bridges, which cost many times the expense of the concrete culvert required to meet the same requirements.

The booklet referred to contains much valuable information and should be in the hands of every concrete worker. It will be sent free for the asking.

The accompanying illustration shows completed culvert with steel form being withdrawn.

CONCRETE ARCHITECTURAL COMPETITION.

The one branch of concrete construction which seems to have lagged behind the others in rapidity of development is residence construction. While considerable progress has been made in this field recently, it is nevertheless to be observed that architects and builders have rather neglected the possibilities of concrete in the building of homes, notwithstanding the fact that a concrete house offers several advantages of fireproofness, permanency and low insurance. In this connection it is interesting to note that the Pittsburgh Architectural Club, which has its headquarters at the Carnegie Institute, has taken steps to encourage and stimulate the interest of the architectural profession in cement house construction. The club is at present sponsor for a competition for designs for a cement house and garage which is attracting considerable interest among architects throughout the country.

The competition is open to practically all architects, and prizes amounting to \$500 are offered by the Universal Portland Cement Company, of Chicago and Pittsburgh.

The designs will be exhibited at the Fifth Annual Art Exhibition, at the Carnegie Institute Galleries, at

Pittsburg, and will probably be published later in booklet form by the cement company.

The jury will consist of Mr. Edward Stotz, president Pittsburgh Chapter, A. I. A.; Mr. Henry Technical Schools; Mr. J. Beatty Orth and Mr. D. E. Allison.

In making the reward the jury will consider the artistic quality of the designs, in regard to the materials used, the excellence of the plan and the practicability of the constructive details, and will endeavor to obtain a design in which the imagination and ideas of the designer, in regard to good architecture, are practically and successfully worked out.

CEMENT PROPERTY IN WEST VIRGINIA.

Congressman, George C. Sturgiss writes us as follows: I desire to call attention to a very valuable cement proposition situated in Monongalia county, West Virginia. It may briefly be described as an inexhaustible limestone stratum, over 100 feet thick, of which at least 40 feet of the lower section is a specially fine limestone for making Portland cement of high grade.

It is found in the valley of Deckers Creek, about nine to eleven miles from Morgantown, the county seat of Monongalia country, West Virginia, situated on the Monongahela river. It has a frontage of over three miles on Deckers Creek, a tributary of Monongahela river, and Morgantown & Kingwood Railroad, extending through the whole length of the valley connecting at Morgantown, with the river, the Baltimore & Ohio Railroad (from Fairmont to Pittsburg), and at Rowlesburg with the main line of the B. & O. R. R.

A large block of this land containing the limestone has been bought by Pittsburg capitalists for development and is situated about eleven miles from Morgantown. The Alpha Portland Cement Company is now rebuilding the plant at Manheim, on Cheat River, just above Rowlesburg, in Preston county, West Virginia, where the same limestone has been tested with most satisfactory results.

Core-drilled sections have been taken from the stratum at various points, and at Sturgisson about eight miles from Morgantown the stone is being mixed by headings driven into the hillside, and samples taken here have been analyzed by prominent chemists and pronounced of the best quality for cement making. Shales of character to be used in cement making are found in abundance in the same hillside and coal can be delivered at the works on either side of the creek at from one dollar to a dollar and a quarter a ton, of a quality well fitted for cement making. There are deposits of fire clay and most excellent building rock and glass sand on this land.

I have a tract of over 2500 acres situated on both sides of the creek and of the railroad, partly timber and almost 2000 acres of it underlaid with this limestone stratum, for which I am willing to take \$25,000.00. This is exceedingly cheap and an investigation will satisfy any one who desires to make such an investment.

Freight rates can be arranged satisfactorily for all rail shipments, and for transfer at Morgantown from rail to river. The river has been made navigable by a system of locks and dams from Pittsburg to Fairmont, and is free from toll.

I shall be glad to furnish any further information including an analysis of the limestone if desired.

BOOK NOTICE.

Proceedings of the fifth Annual Convention of the National Association of Cement Users, for 1909. 700 pages, 9x6 inches, 160 illustrations, edited by Richard L. Humphrey, price \$5.00 including membership to the Association. The volume contains a vast amount of useful and trustworthy information relating to the use of cement in modern building construction. Numerous excellent illustrations. The matter embraced, consists of papers read at the Cleveland convention in Jan. 1909, and discussions of such papers; questions asked by individual members on some points, etc. All of which makes the volume distinctly an educational one, and a record of practical progress made in sound economical concrete construction work. The building regulations of Great Britain, Germany, France, Switzerland, cover ten pages. The index of subjects covers three pages. Mr. Humphrey, President of the Cement User's Association, and editor of the book is to be congratulated.

* * *

The Universal Portland Cement Co., Chicago, have published a pamphlet entitled "Standard specifications and uniform methods of testing and analysis for Portland cement." The object of this little pamphlet is to assemble under one cover the reports of the committees on standard specifications for Portland cement, uniform tests of cement and uniformity in methods of analysis for limestones, raw mixtures and Portland cements. These several specifications are given exactly as they were reported by the various committees who had their preparation in charge. Their collection in this pamphlet will be of convenience to many engineers and cement users. Send for one.

* * *

The Weber Co., Chicago, Ill., new pamphlet "A Review of Concrete Chimneys" describes the development of concrete chimney construction as practiced by the company named and gives an account and a defense of the failure of two concrete chimneys of the company's type. A very interesting pamphlet.

DEATH NOTICE.

Wm. Turner, President of the Phoenix Portland Cement Co., died on January 27. Mr. Turner was apparently in good health up to 24 hours before his death. On the evening of January 26, he was stricken with apoplexy and died the following day.

Mr. Turner has been President of the Phoenix Portland Cement Co., for the past 9 years, he was likewise president of the Imperial Portland Cement Co., of Nazareth, Pa., and President of the First National Bank of Pen Argyl, Pa. He was born at Hope, N. J., on February 9th, 1859, he leaves a wife and three children.

Business men of Superior, Nebraska, are showing great interest in the survey made for the Nebraska Portland Cement Co., which proposes to erect a plant at that point with a daily capacity of 1,000 barrels according to the statement of President C. McLaughlin of the Cement Co.

PACIFIC'S FIRST CONCRETE PIER.

The first concrete pier on the Pacific coast, and a big one it is, has been completed recently. Extending in a straight line 1,600 feet out into the Pacific ocean, this latest example in wharf construction is at Santa Monica, where the longest wharf in the world—the Southern Pacific railroad's pier at Port Los Angeles—is already located.

So far—and the piles of the landward end of the new pier have been in position for several months—the sea has not made the slightest impression on the concrete posts. Teredos, those sea worms which make the life of the wharf builder, a continuous nightmare, are powerless to penetrate the new piles; barnacles cling to them in small numbers, but can do no damage, while the strongest waves of the sea break aimlessly against the smooth concrete and without deleterious results to the wharf which they support.

PAINTING A CEMENT WALL.

The following method of painting a cement wall was described at a recent convention of Canadian master painters. The building had become discolored in places, and the joints were of different color from the surface of the blocks. Two parts of Portland cement, together with one part of marble dust, were mixed with water to the consistency of this paint or a thick whitewash. The wall was well wetted before the application of the paint and kept constantly wet while the material was applied, and then kept for a day in order to make the cement wash adhere to the cement surface. The wash was applied with ordinary whitewash or calcimine brushes, and a man was kept busy playing a spray on it, while the work was being done. The whole secret of success lay in keeping the wall constantly wet.

RICKETSON'S COLORS.

There are probably but few users of building materials in the country who are not already familiar with the excellent reputation of the "Red Brick" Brand Mortar Colors manufactured by the Ricketson Mineral Paint Works of Milwaukee. These colors are made from the purest Bessemer ores by a special process which removes all the oxides that will not stand weathering. So jealously has the purity of these colors been guarded, that in the somewhat more than twenty years during which they have been used and marketed, not a single case of crocking or fading has been reported. The company has recently gotten out a snappy little novelty folder illustrative of this point and showing the range of the line, which is well worth sending for. It will also more than pay any architect or builder to have sample packages of this old reliable brand of colors on his shelves.

Fred B. Lane, Little Rock, Ark., and associates purchased the White Cliffs Portland Cement Company property and will form a new company with a capital stock of \$3,000,000 to continue development and plan the construction of a plant with a daily output of 3,000 barrels of Portland Cement.

THE RANSOM TYPE OF HOLLOW CONCRETE DAM.

There has recently been constructed at Barre, Mass., a new type of hollow concrete dam, which is open on the downtown side and in which the deck is carried by concrete walls placed diagonally at an angle to the flow of the stream. The deck is of course reinforced in accordance with the head of water to be carried, and is supported by concrete arches parallel to the length of the dam and transferring their loads to the walls. The latter diverge from an apex, located in the upstream toe of the dam, at an angle of about 30 degrees, or 15 degrees each side of a line parallel to the flow of the river, and the apices are so spread that the distances between the ends of the walls at the edge of the short downstream apron of the spillway crest are equal. The space beneath the dam is therefore divided into alternate sections wedge-shaped in plan, with one section varying in width from zero at the upstream toe to a given dimension at the downstream edge of the dam, and the other varying from the spacing of the apices at the upstream toe to the same given dimension at the downstream edge. Adjacent spaces, therefore, have their narrow ends, in plan, alternately up and downstream.

A short apron extends downstream from the crest for a few feet, but the remainder of the back face is not covered, leaving the ends of the supporting walls exposed. The crest is arranged for the use of flashboards. The section dam beyond the spillway follows the same design as the latter, merely being carried higher, and dispensing with the rollway crest and apron.

Dams following the same principles but of considerably greater size have been designed, the spillway heights being 44 and 72 ft. and the lengths 610 and 470 ft., respectively. In these instances a change is necessary in the placing of the diagonal walls carrying the deck and the deck arches. They are arranged in plan in diamond fashion, with the long axis of the diamond parallel to the stream flow, and the upstream apex in the upstream toe and the downstream apex beneath the edge of the short apron extending downstream from the crest. The apices at the ends of the short axis of the diamond coincide with the like apices of the next diamond, so that the entire space under the deck is divided into alternate sections of diamonds and wedges, the latter lying between the diamonds and having their apices coincident. In the dam with a height of 72 ft. the base is 87½ ft., and the deck arches are spaced 9 ft. 9 in. apart horizontally. The supporting walls carry the apron on a bracket with a horizontal projection of 8½ ft., and the downstream toe of the walls is 3 ft. upstream from the edge of the apron.

The design is known as the Ransom hollow dam, and is controlled by The Hydraulic Properties Co., of Providence, R. I., who claim for it cheapness, freedom from upward pressure, and on account of the cellular structure and the diagonal placement of the walls, freedom from injurious racking strains and dangerous vibrations. The dams will be constructed on the basis of cost plus a fixed sum, lump sum or royalty.

A new method of bonding new concrete to old is described by Mr. Frank Barber (of the firm of Barber & Young, Toronto, Ont. in a recent article in "The Canadian Engineer." This consists in placing bags of cracked ice on the last surfaces of concrete

placed at night, thus reducing the temperature of the concrete, and consequently retarding its time of setting, so that on the next morning the surface is still plastic and the concrete then placed will set in one mass with the old. The invention of this scheme is credited to Mr. O. L. Hicks, when he was contractor for a reinforced-concrete truss bridge in Ontario. As all of the members in these trusses were of relatively small cross-section, the ice-bags were easily placed at the end of a day's work and it is stated that the method worked very successfully. To what extent it could be applied to heavier work is not as yet known.

INTERESTING ITEMS CONCERNING CONCRETE PRODUCTS.

Manhattan, Kan.—The Rock Ford Dam and Power Co., has begun the work of constructing the concrete poles which are to carry the wires, over which the power generated at Rocky Ford is to be carried to this city. The poles are re-inforced with steel rods and the weight of each is two tons. They are thirty-five feet long, and eighteen inches square. On the inside is a 4 inch gas pipe and they are further re-inforced with a twisted iron rod at each corner. The poles must be handled with derricks when the work on the line is begun. Twenty-five will be set to the mile. The great expense of constructing a line of this kind will be an economy in the end as the line, when once built, will be practically indestructible.

* * *

Brodie Hydraulic Concrete Press Co., Great River, N. Y.—Manufacturing articles from concrete and machines for same; cap., \$100,000. Incorporators: L. H. K. Brodie, Hastings-on-Hudson; G. W. Kyburg, Tenaflly, N. J.; C. B. Hobbs, Great River.

* * *

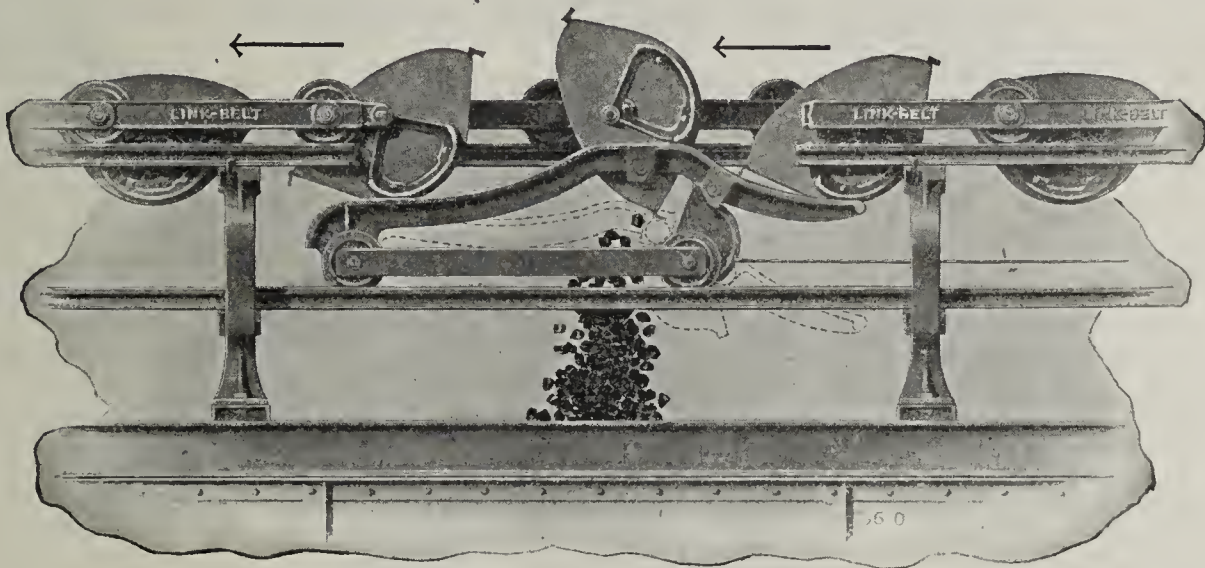
The Altman Sand Company, Germania Bank Building, Pittsburg, has completed the erection of its new sand plant at Thompson Station, Warren county, Pa., and placed it in operation for the first time on September 1. The concern has built a large modern and well equipped plant, in which complete labor-saving equipment, conveying systems, etc., and powerful crushing machinery have been installed. The company has a large tract of land which is underlaid with a twenty-foot vein of sand rock, which an analysis has shown to contain over 99 per cent silica. The quarry has been opened, and the sand rock is lowered on an 1,800-foot tramway, which has a fall of 700 feet to the plant. The plant itself is equipped with a nine-foot pan and twelve-inch Muller wheels. It has a capacity of about forty tons per hour, all of which is being shipped at the present time. The outlook for the success of the new concern is excellent, as enough business has already been booked to insure the steady operation of the plant to its capacity for the remainder of the year at least.

* * *

The Western Cement Products company, an organization formed in Denver a year ago with a capital of \$200,000, has acquired thirty-two acres of land in South Denver and will erect a plant having a capacity for manufacturing about \$1,000,000 worth of products annually.

PECK CARRIER

**The Standard Machine for Conveying
Cement, Crushed Rock, Hot and Cold Clinker,
Coal, Etc.**



In our book describing this CARRIER we have included an explanation of the principles that govern correct construction and operation of Conveying Apparatus. Here is a quotation from page 15:

"Don't use a Carrier without crossrods between the chains: the weight of the buckets and load will cause the chains to tilt inwardly and the rollers will bear on the inside corner of the rails, instead of on the tread."

If your name is on our list you'll be sure to receive a copy; if not, please notify us.

LINK-BELT COMPANY

PHILADELPHIA

CHICAGO

INDIANAPOLIS

NEW YORK, 299 Broadway

ST. LOUIS, Missouri Trust Building

DENVER, Lindrooth, Shubart & Co.

PITTSBURGH, 1501-2 Park Building

SEATTLE, 439-440 New York Block

NEW ORLEANS, Wilmot Machinery Co.

The Most Careful Design

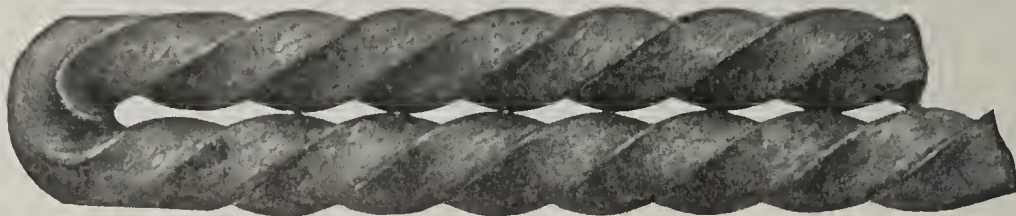
may be defeated by the use of inferior reinforcing steel.

—It is satisfaction to feel secure in the knowledge that the reinforcing material in your concrete structure meets the most exacting requirements of your design.

M/B *Special* Open Hearth Bar (Cold Twisted) **FOR REINFORCING CONCRETE**

is a superior steel manufactured under most rigid specifications. It is the only known steel which has ductility and high elastic limit combined.

—Costs no more than ordinary deformed steel and guarantees the safety of your concrete.



M-B Bar, elastic limit, 64,000 lbs. per square inch. Specimen was bent cold.

—The M-B Bar is rolled from new Billet Stock. Its elastic limit is 60,000 lbs. per square inch yet it is not brittle for it can be bent double cold without fracture. This feature means a saving of several dollars a ton in handling and bending alone. Shown by Government Tests to have highest mechanical bond.

—“The Bar That Never Failed” is a booklet which contains formulæ and much valuable information concerning reinforced concrete. You should have a copy of it. Write today.

William B. Hough Company
Chicago, U. S. A.



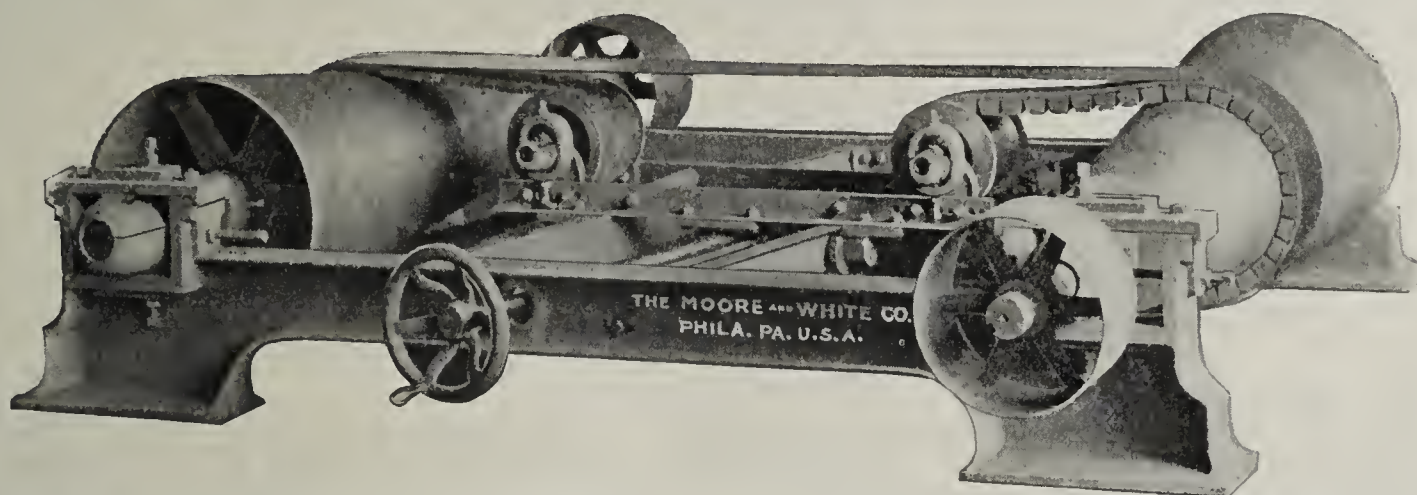
ENGINEERS

FOUNDERS

MACHINISTS

"M. & W." Speed Changes

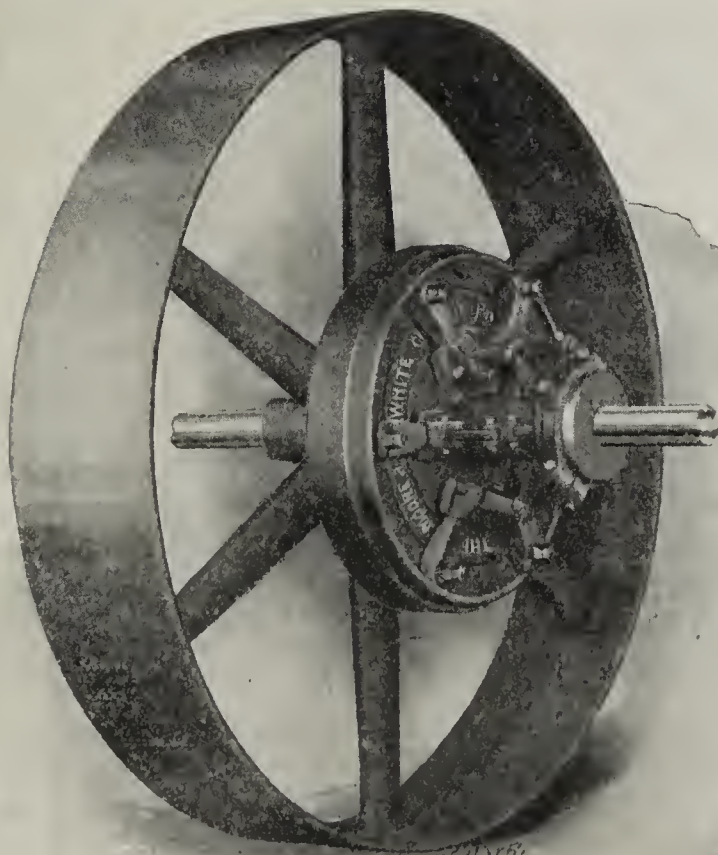
SIZES 1 to 200 H. P.



If you are interested in variable speed drive for cement machines we would be pleased to explain the most effective device ever offered to overcome exacting speed requirements specially adapted for Kiln Drives

One mill man writes: "We are about to install another of your SPEED CHANGES. We can speak well regarding the one you sent us two years ago—not a penny for repairs of any description. Satisfaction all the time."

"M. & W." Friction Clutches

USED EXTENSIVELY
IN CEMENT MILLS

"M. & W." FRICTION CLUTCHES and SPEED CHANGES are in use upon all kinds of work, such as Driving Electric Light, Machinery, Wood and Iron Machinery, Paper Machinery, Cotton and Wool Machinery. Send for Catalogues on the above Subjects.

GLIDDEN

GLIDDEN'S LIQUID CEMENT

Uniforms the color of Concrete-Cement and Plaster surfaces, producing a waterproof result.

Made in Sandstone finish and several shades along the lines of Colonial and Pompeian Buffs.

Inexpensive and easily applied.

Samples and full information gratis upon request.

A product of The Glidden Varnish Company, exclusively.

The Glidden Varnish Company, CLEVELAND, OHIO

GLIDDEN



JEFFREY RUBBER BELT CONVEYERS

Cost less to install and less to operate and maintain than any other make.

THE BELT USED is of the very best quality obtainable for conveying purposes.

THE BELT CARRIERS are strong, accurate and light running. They are perfectly self oiled and permit a minimum over all width of conveyer.

LET US FIGURE ON YOUR REQUIREMENTS

Elevating and Conveying Systems for all purposes. Coal and Ashes Handling Systems for Power Plants.

Send for Catalog Aa81.

THE JEFFREY MFG. CO., Columbus, Ohio

Limestone and Shale

FOR MANUFACTURE OF

Portland Cement

ON THE

Illinois Central Railroad

IN THE

West and South

Coal, Water and Good Labor

For Full Particulars Address

J. C. CLAIR,

Industrial Commissioner, I. C. R. R. Co.

1 Park Row - Chicago



McCaslin Conveyor over Storage Bin Handling Hot Clinker

The McCaslin Conveyor

Acknowledged by Competent Engineers as the best Conveyor in the world for handling hot clinker, stone, etc., in **CEMENT PLANTS.**

Low Cost of Maintenance Absence of Shut Downs
Maximum of Efficiency

Manufactured solely by

Mead, Morrison Mfg. Co.

BOSTON

NEW YORK

CHICAGO

Catalog on Request

Send Us Your Specifications for an Estimate



STEEL BARS

FOR

CONCRETE REINFORCEMENT

Plain Rounds, Plain Squares, Square Twisted

All sizes from 5-16 to 1¼ inches. Flat bars from ¼ x 1 inch to ¾ x 2½ inches

WE GUARANTEE IMMEDIATE DELIVERY

No extra charge for cutting to length

FRANKLIN STEEL COMPANY, Franklin, Penn.

Location for Cement Plant

Extensive Deposits of Raw Material. Proximity to Large and Growing Markets. Low-Priced Fuel Supply.



THERE ARE several desirable locations for Portland Cement Plants along the Santa Fe, where the advantages enumerated are to be found. If you are interested you can secure full and detailed information by addressing this office.

The SANTA FE is glad at all times to co-operate with those seeking locations or desirous of investigating conditions in territory tributary to its line. Correspondence from interested manufacturers is invited.

WESLEY MERRITT, Industrial Commissioner A., T. & S. F. Ry.
1122 Railway Exchange Building CHICAGO, ILL.

Face Your Blocks

Make Them White

Do You
Use

WHITE SAND

Leading contractors specify our pure White, Washed and Screened Silica Sand for fine work in ornamental stone, block facing, porch work, ornamental lawn fixtures, vases, etc.
This sand is shipped both DRY and DAMP.
Prices and Samples on request.

BALLOU'S WHITE SAND COMPANY
MILLINGTON, ILLINOIS

"Laying Concrete Has Begun on the Miraflores Lock"

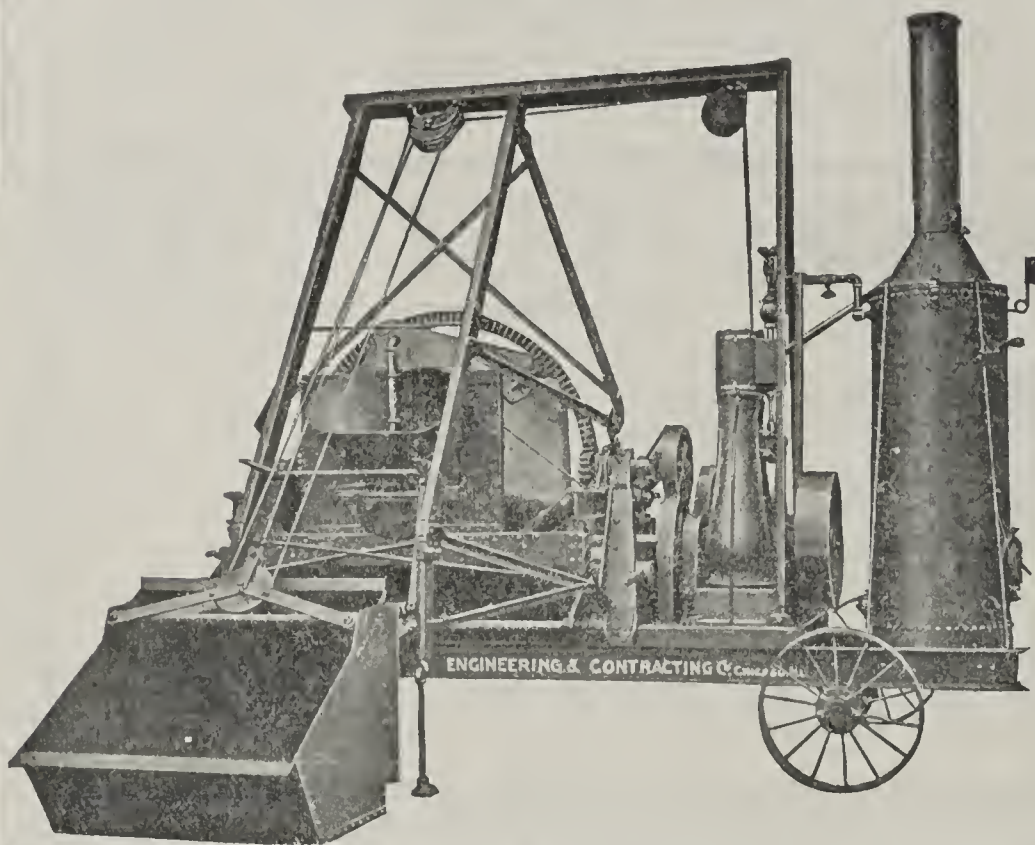
The above quotation from the "Canal Record" means that the large two cubic yard CHICAGO IMPROVED CUBE MIXERS shipped to Panama some months ago are getting to work on the greatest concrete locks in the world.

The Chicago Improved Cube Mixer was adopted by the engineers of the Panama Canal after practical test on preliminary construction alongside all other leading makes of concrete mixers.

This fact means a great deal more than that Chicago Improved Cube Mixer has won a commercial victory over its competitors. The locks of the Panama Canal are to be of unprecedented size. Upon their perfect construction rests not only the successful operation of the canal, but the reputation of the engineers who decided on a lock canal in face of strong opposition arguing the danger of locks. No chance is being taken that can possibly be avoided in building these locks. No factor which will contribute to their perfection is being neglected.

The greatest of all the factors working toward success is perfect concrete, and the selection of materials and machines for making concrete has been guarded from error in every possible way. That the Chicago Improved Cube Mixer was selected stamps it as the superior of all other concrete mixers.

Write for catalogue No 7, describing
The World's Greatest Mixer for the World's Greatest Canal.



**MUNICIPAL
ENGINEERING & CONTRACTING CO.**

RAILWAY EXCHANGE BUILDING, CHICAGO

New York Agents: Motley, Green & Co., 68 Broad Street
New England Agents: Dyar Supply Co., Boston, Mass.

Pacific Coast Agencies: Lansing Wheelbarrow Co., San Francisco, Cal.; F. T. Crowe & Co., Seattle, Spokane, Tacoma, Portland.

Highest Class Cement Rope Sacks

CEMENT SACKS FURNISHED PLAIN OR PRINTED

Samples and quotations
furnished upon request

**CONTINENTAL PAPER
BAG CO.**

Paper Mill, Bag Factory and Printing Plant

RUMFORD, MAINE

Address inquiries to General Office,

**Whitehall Bldg., 17 Battery Place
NEW YORK CITY**

Hess Furnaces



**No. 45
"Leader" Hess
Steel Furnace
Price \$49.00**

Delivered East of Omaha and
North of Ohio River
Pipes and Registers Extra

for the past 7 years, have been sent to customers in every state in the Union, freight prepaid,

On Approval

and the money held back till sixty winter days of actual trial have proved that all our claims for superiority have been fulfilled.

Isn't this worth looking into? Could we offer such liberal terms if we didn't know that the Hess Furnace excels in service, simplicity, efficiency, economy?

All we ask of you, if you need a furnace, is to investigate—to put your name on a postal card, mail to us and ask us for our booklet "Modern Furnace Heating." This booklet is an authority on furnace heating, and copies have been requested by many colleges, libraries, etc., for reference in engineering and mechanical courses. It instructs fully in the principles and practice of furnace heating, and should be in the hands of every builder and house owner. It is free on request.

**In Buying Direct
From Our Factory You Pay Only
One Profit—A Small, Factory Profit.**

Our prices are not inflated with the usual cost for salesmen, branch stores, agents' and dealers' profits. The factory profit only, satisfies us, and you will be surprised at how much we can save you.

Special Heating Plan Free Before You Order

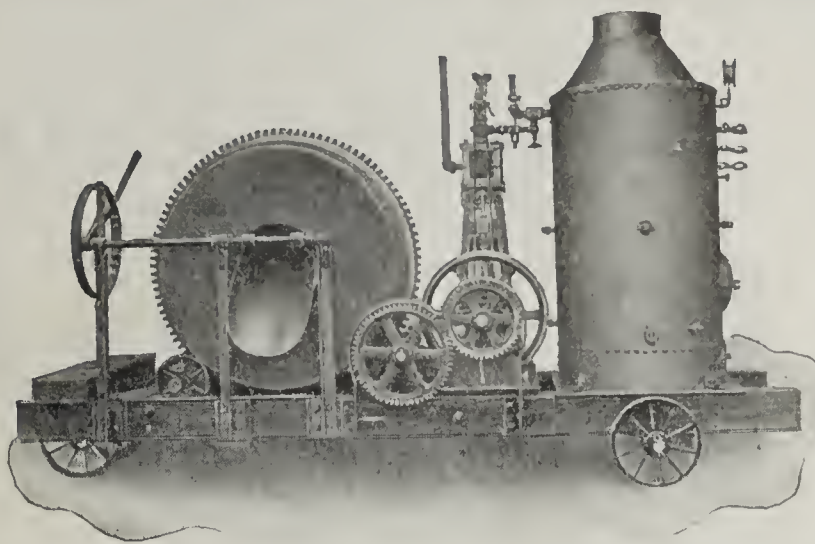
Let us have our experts prepare a special plan for heating your building. It will cost you nothing, and put you under no obligation to buy of us. Our thirty-six years of experience in designing heating equipments makes this free plan valuable to you.

Ask us more about it. A postal card today will serve the purpose.

**Hess Warming & Ventilating Co.
919 Tacoma Bldg., Chicago.**

Actual Strength Tests Prove

that the *Ransome* is easily foremost in thoroughness and uniformity of mixture—that it yields concrete of *maximum strength* with a *minimum consumption* of cement.



Ransome Mixer with chute in discharge position.

Discharges Without a Tilt

The *Ransome* not only *mixes*, but *also discharges* its batch, or any part of it, with unfailing evenness and uniformity. A series of steel scoops inside the drum picks up the materials and carries them upward to a complete half turn of the drum, then dashes them from top to bottom again with sufficient shock to break up any clusters or masses and to grind in the cement.

The rotating movement, the reciprocating backward and forward movement across the drum and the constant downpour of materials from top to bottom, positively insure absolute thoroughness and uniformity of mixture. It's the thoroughness of *method* that makes the thoroughness of *mixture*.

To discharge a batch or any part of it, a quick turn of a lever lowers a light steel discharge chute into position to intercept the mixture as it slides out of the scoops, and—Presto!—out flows the concrete into buckets or barrows—no tilting—no tipping—no labor—no loss of time! All tendency to “ball” or “mass” in discharging is effectually prevented.

The Ransome Mixer

The *Ransome* outclasses all other mixers in the number of batches mixed and discharged per day. Being non-tilting, the materials do not have to be elevated so high to get them into the mixer and an enormous saving in the cost of handling is effected. Owing to the rolling friction, it costs less for power. Having fewer wearing parts than you can count on one hand and scarcely more parts all told than you can count on two hands, there are no break-downs and practically no repairs. But why go on? There are a hundred and one *substantial Ransome reasons*. To know them in detail—

Ask for our Booklet “In the Wake of the Ransome”

William B. Hough Company

“Where the Good Contractors’ Machinery Comes From”

*Large Stock carried in
our Chicago Warehouses*



*Monadnock Building
Chicago, U. S. A.*

Horse Power and Horse Sense



IF YOU were buying horses, and 125 cost you not a cent more than 100, and they were exactly the same kind of horses, which would you take—the 100 or the 125?

Q Of course, you *would*!

Q Well, then, here's another little problem in simple arithmetic:—

Q If all hoisting engines, *with one exception*, have boilers built for only 100 lbs. working pressure, and that one exception is built to operate continuously on 125 lbs. working pressure, which will *you* take—*cost being the same*?

Q You see, it's like this:—

Q "Wrightworth" boilers and the "Wrightworth" engines throughout are built to carry 125 lbs. safe working pressure as against a maximum of 100 lbs. in other engines.

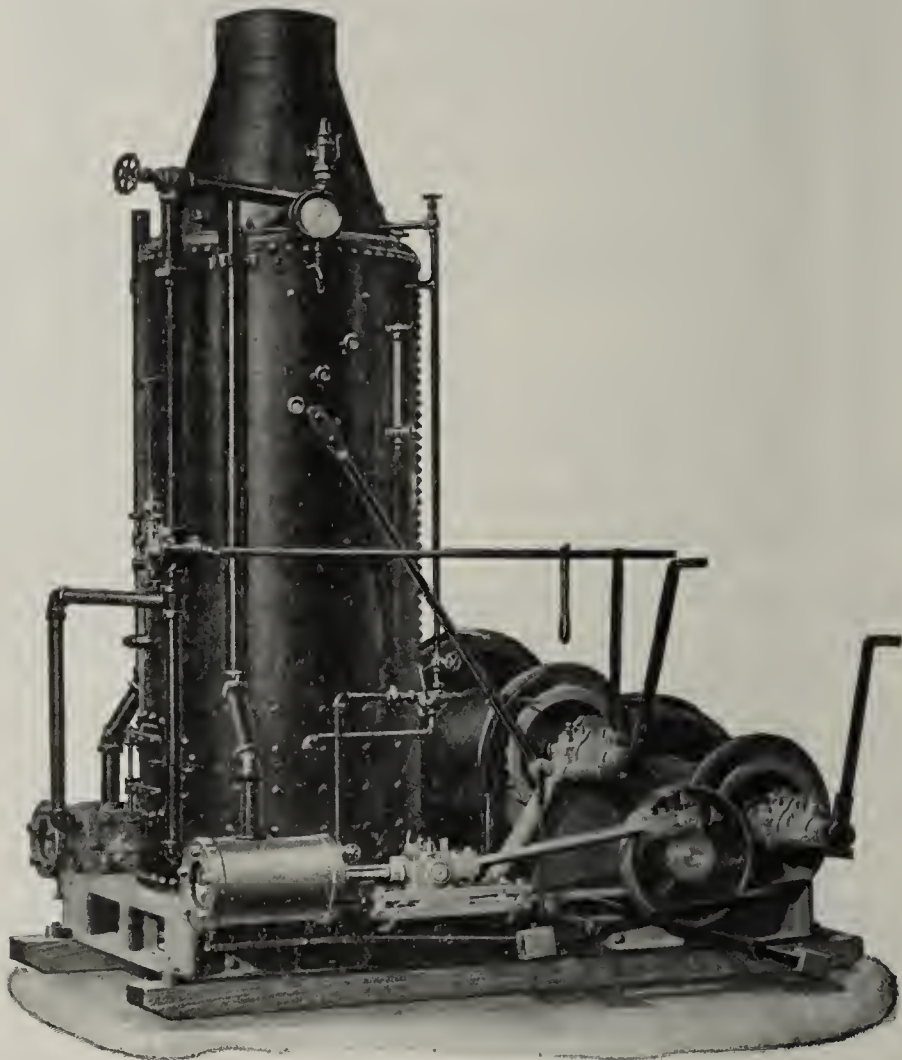
Q A tremendous excess in power in favor of the "Wrightworth," *at no additional cost to you*.

Q Now, what's the horse sense of this thing? Just this:—

Q *Unless you get the "Wrightworth," you are not realizing the full purchasing power of your money.*

Q If you pay the "Wrightworth" price, as you must, for anything less than the "Wrightworth," then you *pay* for power and efficiency in excess of what you actually get.

Q In the "Wrightworth" you get not only the maximum power, but also an engine of latest type and most improved design, embodying fundamental *betterments*—all for the same money!



The "Wrightworth"

*has—strongest main drum gears
—largest friction area—most
power—series of bronze and
steel discs between thrust screw
and thrust pin to prevent wear
—fewest number of bolted parts
—greatest durability—greatest
efficiency.*

William B. Hough Company

"Where the good contractor's machinery comes from"

Monadnock Block

Chicago, U. S. A.



When You Consider Efficiency, Cost of Repairs and Capacity

"From the writer's quite extensive experience with all kinds of jaw and gyratory crushers, the

McCULLY

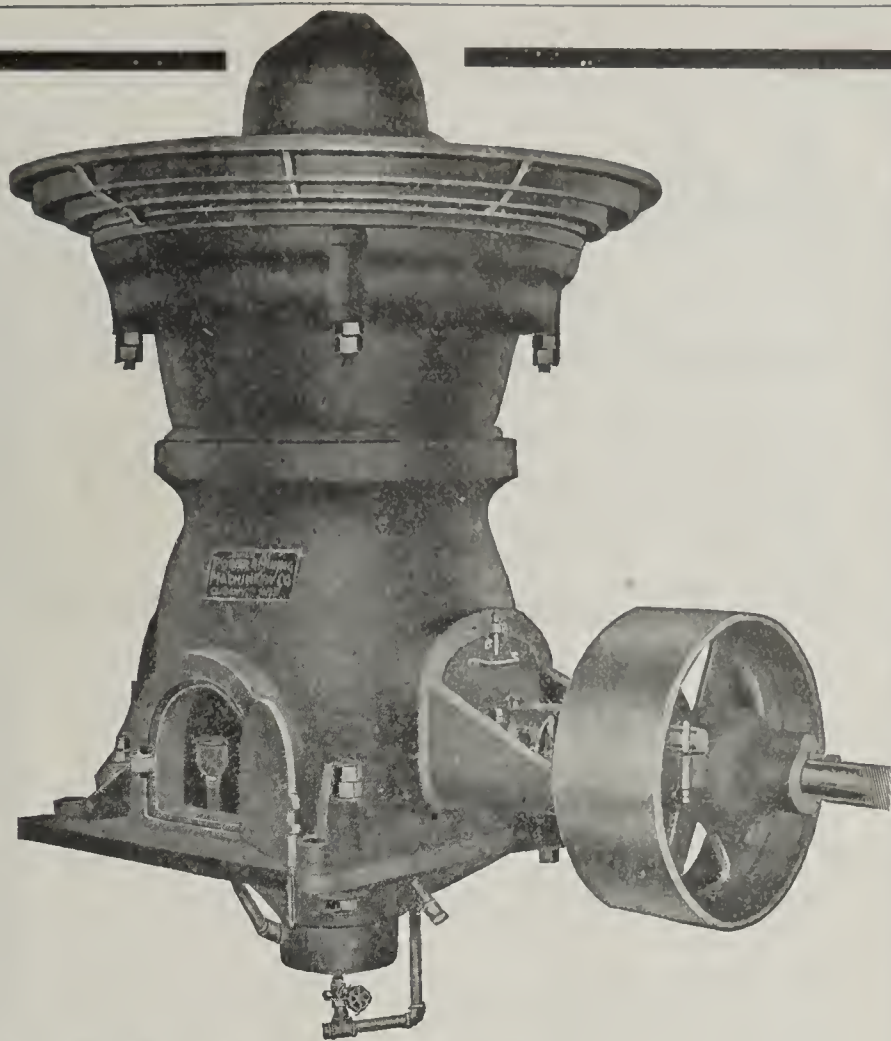
is top of all when you consider efficiency cost of repairs and capacity."

He knows because he has used them. We know too and are ready to show you if you'll send name and address for

Catalog 14, Rock Breaking Machinery

Cement Mill Machinery

Everything for a Complete Plant



POWER AND MINING MACHINERY COMPANY

CHICAGO

NEW YORK

EL PASO,

MILWAUKEE, WIS.

ATLANTA

MEXICO CITY

SAN FRANCISCO

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

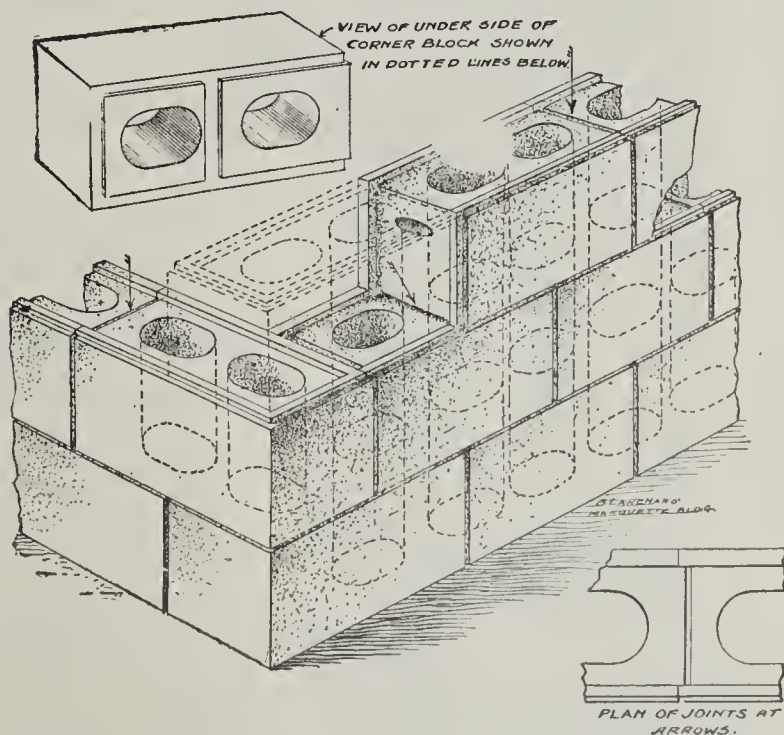
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting Face-Down Machine by the Wet Process

The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and agents wanted in all states and foreign countries.



DIAMOND CONCRETE MACHINERY COMPANY

Chamber of Commerce Building,

Chicago, Illinois

Adjustable Steel Centers

Makes Concrete Sewer and Culvert Work
Cheap, Easy and Very Profitable

No large amount of money is required
either to lease or buy. No high-priced
mechanics are needed where

Our Patented Steel Centers

are used. They will outlive you, and
require no repairs.

Telegram.

Ship today four five-foot sections of thirty-six inch culvert forms to
Morris, Illinois. Joliet, Ill., Sept. 19, 1908.
Joliet Steel Construction Co.

Their Second Telegraph Order.

Ship today two five-foot sections thirty-six inch forms to Des
Plaines, Illinois. Joliet, Ill., Oct. 14, 1908.
Joliet Steel Construction Co.

Their Third Telegram.

Ship to McNab, Illinois, at once, two Special Centers, six feet long,
four feet diameter, per yours even date. Joliet, Ill., Sept. 27, 1909.
Joliet Steel Construction Co.

Dealers and Other Representatives Wanted Everywhere.

Adjustable Steel Centering Co.

48 Forest Avenue, : : Fond du Lac, Wis.

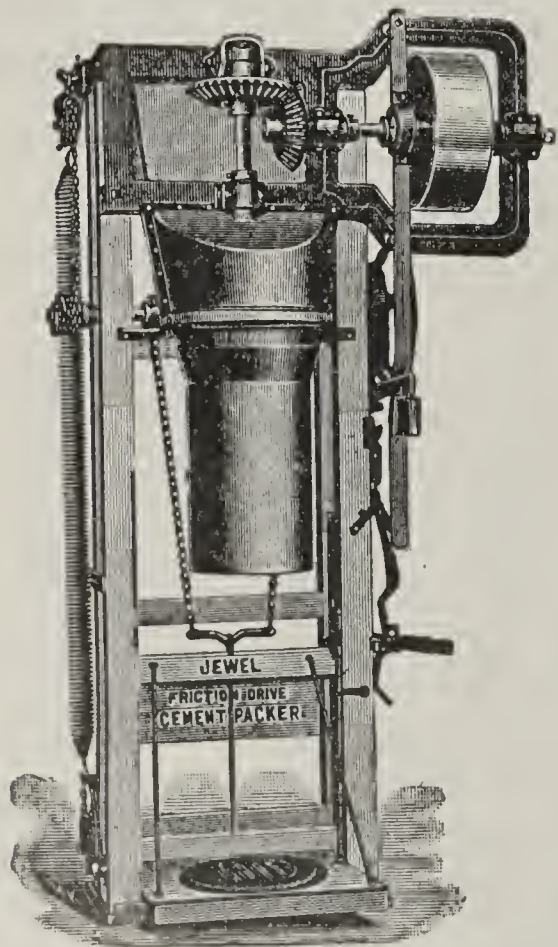


Sixty-inch Reinforced Concrete Sewer, Appleton, Wis.

Chas. H. Vinal, Construction Engineer.

Notice skidway track in bottom—our Special Center—on which collapsed
six-foot rear full-circle sections are slid to the front by two
men for re-setting only as fast as needed.

There is more Cement being packed by the "S. HOWES" Company's
Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and
sacks.

The "JEWEL" FRICTION driven cement Packer, specially
constructed for rapidly packing sacks.

Both machines are equipped with friction pulleys, heavy iron
frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most
durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company
SILVER CREEK, N. Y.

Why Concrete Needs to be Waterproofed

Ordinary concrete lacks stability. It absorbs moisture. This moisture freezes and expands. Then it thaws. This freezing and thawing causes the concrete to disintegrate, to crack and crumble.

For the better building purposes concrete must be free from dampness. It must not absorb moisture. Hence it must be waterproofed.

Aquabar

will thoroughly and permanently waterproof concrete. It affords positive protection against any destructive effects of moisture. It makes concrete absolutely impervious to dampness.

Aquabar's simplicity enables unskilled labor to successfully handle it. One two-gallon can is dissolved into each barrel of water used in mixing the concrete. As the water comes in contact with every particle—so does the Aquabar. As the concrete sets, the Aquabar crystallizes, sealing completely every void between the sand and cement. Thus an absolutely waterproofed construction is formed.

Aquabar will waterproof any concrete construction—walls basements, floors or stucco coatings.

Our engineers will give your case their personal attention, without charge, if you will write us the full particulars about your concrete construction. Also write for our two free booklets and learn all about waterproofing.

Girvan-Nachod Co.

General Sales Agents

1228 Locust Street, Philadelphia, Pa.

34 W. 33d St., NEW YORK CITY, N. Y. Tel. Madison Square 5296.

AGENTS IN ALL LARGE CITIES.

Note:—We also manufacture Aquabar Wash, which is wonderfully effective in weatherproofing old concrete walls.



Universal is Uniform

Uniform in soundness—
Uniform in strength—
Uniform in fineness—
Uniform in color—
Uniform in specific gravity—
Uniform in setting qualities—
Uniformity means superiority.

Use Universal—it produces uniformly excellent results.

Universal
Portland Cement Co.
Chicago — Pittsburg



DEXTER Portland Cement
THE NEW STANDARD

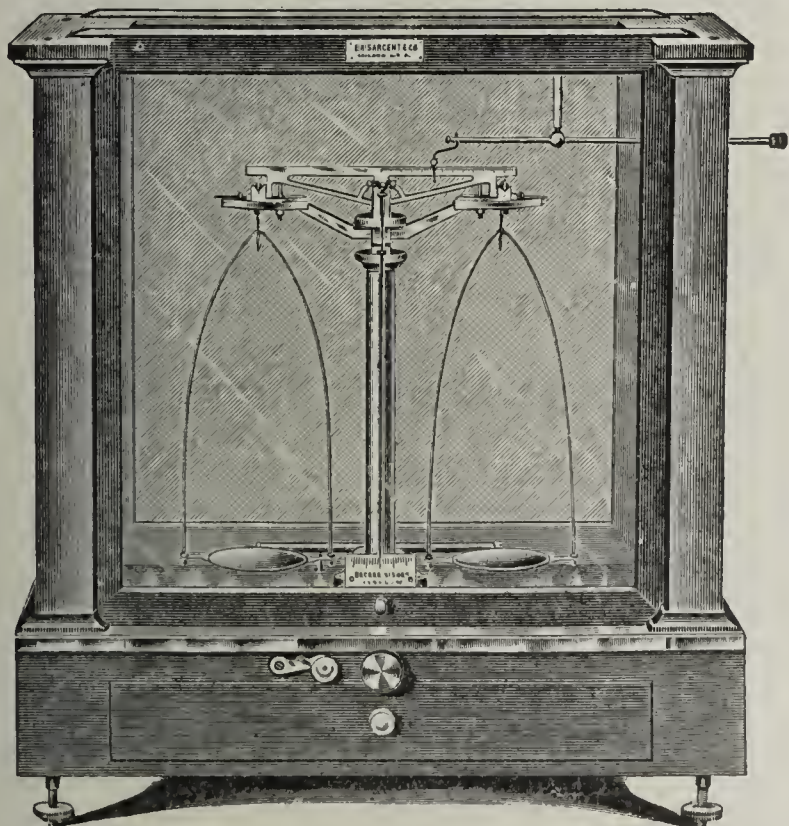
Sole Agents **SAMUEL H. FRENCH & CO.** Philadelphia



HAVE YOU AN IDEA?

If so write for our books: "Why Patents Pay," "What to Invent," "100 Mechanical Movements" and a Treatise on Perpetual Motion—50 illustrations. All mailed free.

F.G. DIETERICH & CO. Patent Lawyers and Experts
801 Ouray Block WASHINGTON, D. C.



E. H. SARGENT & CO.

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN

CHEMISTS SUPPLIES

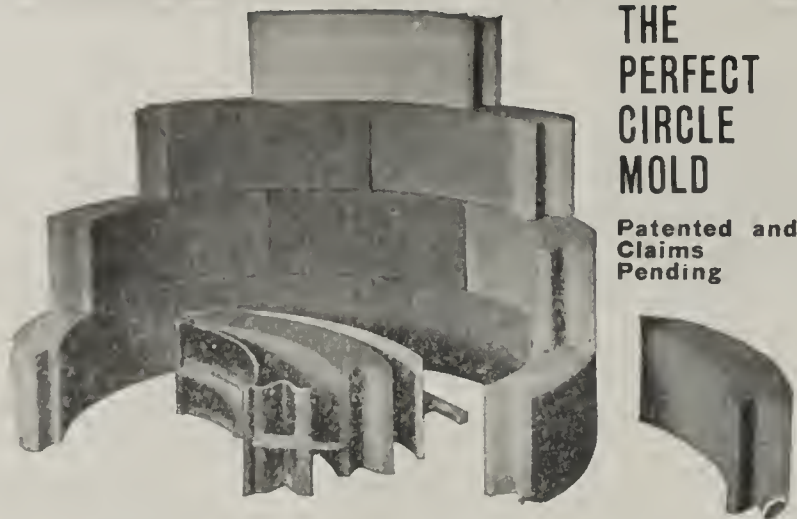
Of high grade only.

We call particular attention to our Cement Mould, Vicat Indenting Apparatus, as improved by us, Gilmore's Needles, Jackson's specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

CHICAGO



THE
PERFECT
CIRCLE
MOLD

Patented and
Claims
Pending

The Perfect Mold was invented by C. S. Wert, of Kendallville, Ind. Manufactured in any sizes. In ordering give the Inside Diameter. The three most in use are No. 1, with diameter of its circumference 3 ft; No. 2, diameter of its circumference, 5 ft. No. 3, diameter of its circumference, 7 ft. Also 10, 12 and 14 ft. Diameters used for silos.

CONSTRUCTION.

The circle mold is built of No. 10 gauge sheet steel, reinforced with T-Iron. The molds are 8-in. high, 4-in. thick, making them strong and durable. These curbing blocks can be made on the ground or floor, or can be made on wooden pallets. Those in the concrete manufacturing business cannot afford to do without one of these molds, as all up-to-date concrete plants are equipping themselves with one or more of my curbing molds, for they all see at a glance their importance and utility, simplicity in operation, durable construction, and lasting qualities in products, as well as completion of a well equipped plant, showing the ability of a man's occupation or business. These molds are no experiment but an up-to-date invention, practicable, durable, simple and useful, and are only appreciated by those who have them in store. Selling at a price within reach of all. The output of these molds is grater than can be produced on any other mold, thus reducing the labor and cost of making the products, and also increasing the Profits.

These molds will enable you to make better products than can be produced on any other machine or model and sell for more money. Just what an up-to-date concrete constructor needs is an up-to-date plant. In a class by themselves, possessing many advantages over all others. Absolutely the best and cheapest molds ever offered to the public.

Do you know that 99 concrete cement men out of every 100, who are successful in their business, purchase the best molds in the land, and they are found and manufactured by C. S. Wert, who is the inventor, manufacturer and sole owner. Write for prices. Address, C. S. WERT, 602 N. Main Street, Kendallville, Indiana.

2c Will Mail This
Ready-Made Letter

Sign your name, check off what you are interested in, and mail to-day:

Mracle Pressed Stone Co.,
Dept. L., Minneapolis, Minn.

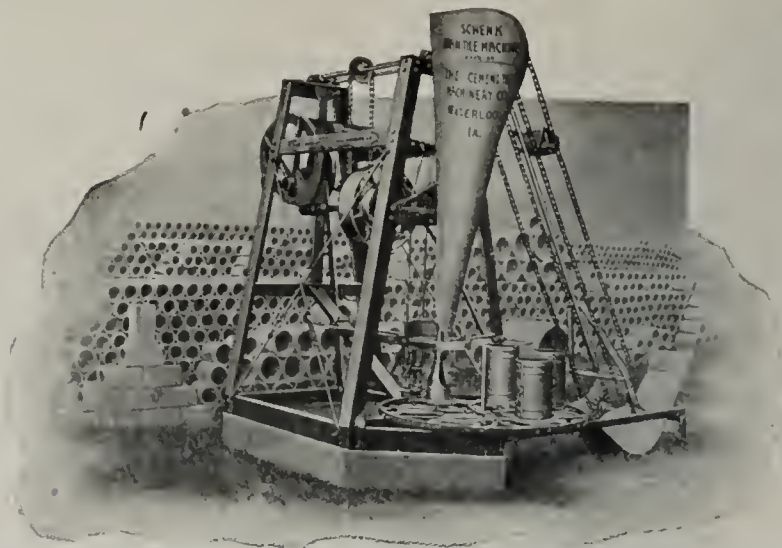
GENTLEMEN:

Please send me FREE your new 1910 CATALOGUE showing new features; Collapsible Steel Forms for Culvert, Conduit and Sewer Work; New Magic Tamper; New Revolving Sand Screen; Miracle Positive Feed Continuous Mixer; New Ornamental Molds and other new developments. Also include your Latest Discount Sheet. I am especially interested in (check off below.)

Double Air Space Block Machines.....	☐
Side Face Single Space Block Machines	☐
Face Down Single Space Block Machines	☐
Special Plates for Ornamental Work...	☐
Brick Machines (3 styles).....	☐
Cement Pipe Molds.....	☐
Bell Attachments for Above.....	☐
Bevel and Tongue for Above.....	☐
Batch Mixers.....	☐
Continuous Mixer (Special Booklet)...	☐
Collapsible Steel Forms.....	☐

Name _____

P. O. Address _____



Would You
Reduce the Price?

If you had originated the idea of manufacturing cement tile by machinery, placed the first machine on the market and fostered it to success; if you knew your machinery to be the most efficient, the most popular equipment, and considered the only proven success, would you reduce the price?

No, we think you would not. But here is the point: The time has come when there must be a greater distribution of tile factories—the trade demands it. We have grown from a small start in the machinery business to the largest exclusive concrete machinery manufacturers in the world. We have a plant capable of turning out in the year 1910 two hundred Schenk machines, and we figure if we can manufacture and sell this number we can afford to reduce the price. Thus you get the benefit of our almost phenomenal success, for every community is offering an opportunity for the manufacture of this product and you are now able to get into the business with but a comparatively small investment.

Get Our Catalog

In this advertisement, space is too limited to explain fully the details of our new selling plan, and in order that you may better appreciate the facts about the business and the real merits of the Schenk Machine we have published a little booklet, "Money in Cement Tile," which will be sent to you absolutely free. Just fill out the coupon below.

THE CEMENT TILE MACHINERY CO. WATERLOO, IOWA

FREE INFORMATION COUPON

I am interested in the manufacture of cement drain tile. Kindly mail me complete information regarding your 1910 proposition, also copy of "Money in Cement Tile."

Address

Name

Town

State

The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa.

WANT COLUMNS.

Advertisements in this column are inserted at the rate of two dollars per inch per issue—and no advertisement will be taken less than two dollars and must be paid strictly in advance.

PURCHASING AGENT.

Desires employment—fully qualified—seven years experience with largest cement company—highest class references. Address, B, Care Cement & Engineering News, Chicago, Ill.

Cement superintendent open for position. Mechanical engineer, 12 years' experience designing, building and operating. Address H. R., care Cement & Eng. News.

POSITION WANTED.

By young man 38 years old. Ten years' experience as Chemist, Assistant Superintendent and Superintendent in the manufacture of Portland Cement by both dry and wet process. At present employed, but desires change of location. Address, W. H. Simmons, care Cement & Engineering News.

WANTED.

Position as sales manager or assistant sales manager for cement plant. Have six years experience. At present employed, but desire change. Address G. D., care Cement and Engineering News.

WANTED.

Two first-class, experienced traveling Portland cement salesmen for territory west of the Mississippi river. No beginners or parties handling other lines need reply. Give references, also salary expected. Address, Salesman, care Cement & Eng. News.

WANTED.

First-class, second hand Air Compressor with cross compound steam and air cylinders and Corliss gears, size: 12-22-18 $\frac{1}{4}$ -11 $\frac{1}{4}$ x36. Address W. F., care Cement & Eng. News.

WANTED.

If you are interested in pumps of latest and best styles, send to us for book and catalogue. Pumps of all styles and for all used. The Columbus Steam Pump Works, West Broad street, Columbus, Ohio.

WANTED.

Position as chemist by young man having college education and experience in dry process mills. References furnished. Address W. P., care Cement & Eng. News.

WANTED.

Position by chief chemist with technical training and four years' practical experience. Can furnish the best of reference. Address, R. E. R., care Cement & Engineering News.

FOR SALE.

Brass letters and figures to embed in cement walks, curb blocks, etc.; reversed letters and name stamps to make impressions in cement; send for price list. Knight & Son, Box F, Seneca Falls, N. Y.

WANTED.

Position by chemist having 8 years' experience, 3 years as chief chemist. References furnished. Address A. A. B., care Cement & Eng. News.

Peerless Portland Cement

MANUFACTURED AT UNION CITY, MICH.

Every Barrel Guaranteed

Fineness, Uniformity of Color and Sand Carrying Qualities equal to any Portland Cement Manufactured

FOR SALE

2-100-in. FANS or BLOWERS
1-110-in, " " "

Water Jacketed Bearings—Pulley Drive—Upward Discharge—Made by the American Blower Co., Detroit, Mich. Used only a few weeks. In good condition. Will be sold at a Bargain.

ADDRESS: Peninsular Portland Cement Co.
JACKSON, MICH.

The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker
1½ inches diameter from the kiln
and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

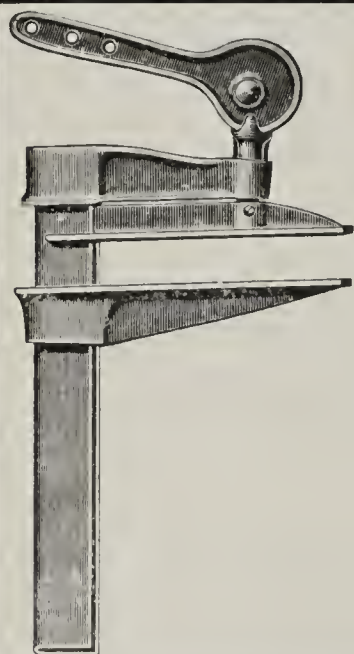
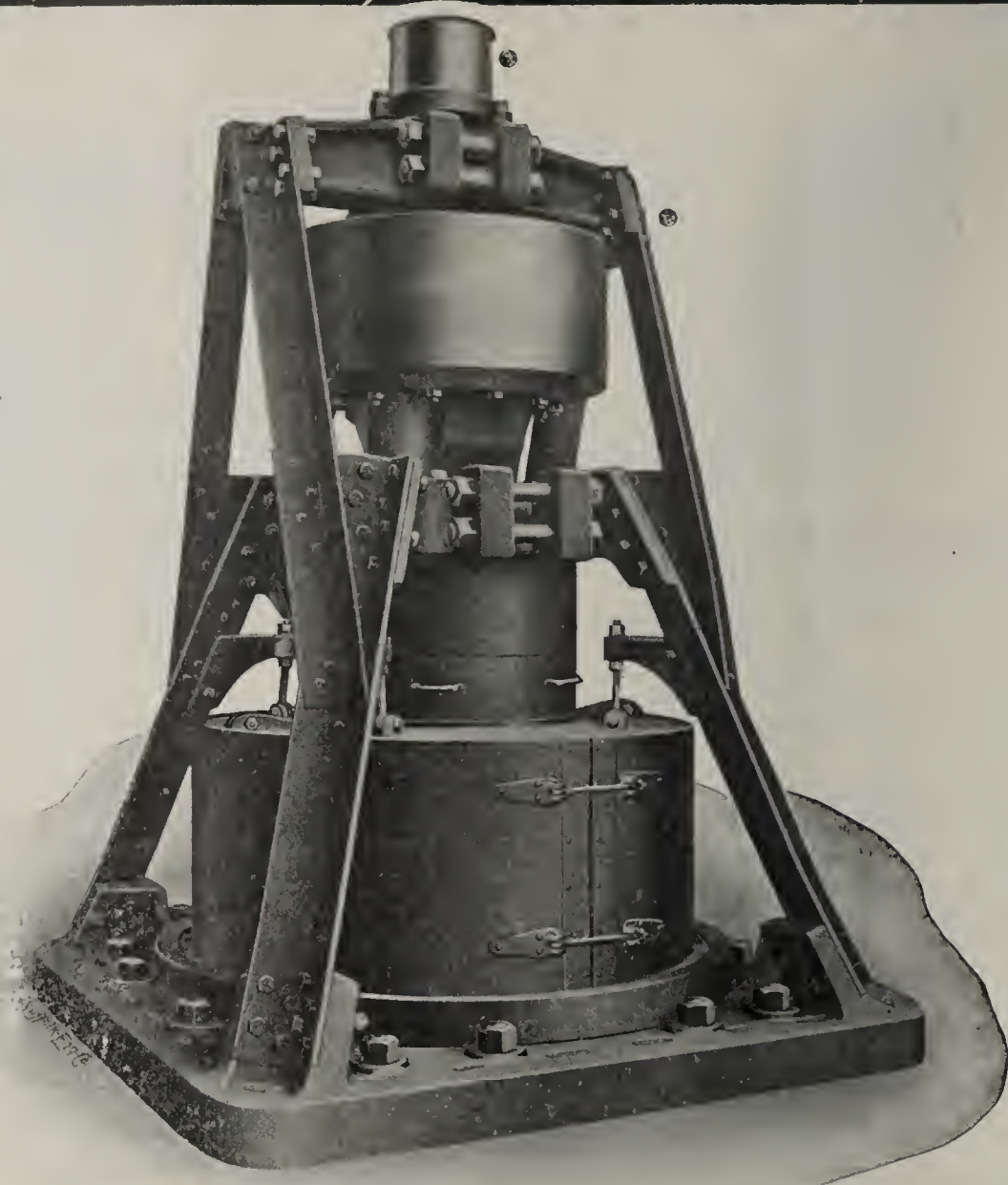
It saves cost in attention.

MANUFACTURED BY

BRADLEY PULVERIZER CO.

37 Walbrook
LONDON, E. C.

92 State Street
BOSTON

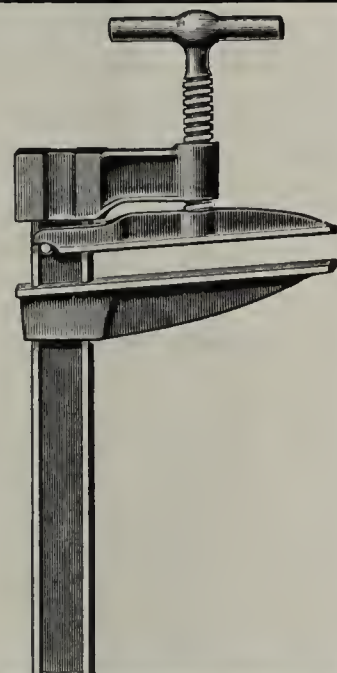


COLT'S CLAMPS

Quick Acting. Time Saving.
Use them with your Moulds and Curbing.

Ask for catalogue No. 156.

BATAVIA CLAMP CO. 101 Center St.
Batavia, N. Y.



Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - = 645 No. Sixth St., Terre Haute, Ind.

THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

Design, Construction, Remodeling and Operation
of Portland Cement Plants

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street
New YorkCanadian Express Bldg.,
Montreal, Can.1121 The Rookery
Chicago425 Washington St.
San Francisco, Cal.Monongahela Bank Bldg.
PittsburghSyndicate Trust Bldg.,
St. Louis, Mo.Norfolk House, Cannon St.
E. C., London

The Osborn Engineering Co.

OSBORN BUILDING, CLEVELAND, O.

Civil, Mechanical and Electrical Engineers

Experts in the Designing of

CEMENT PLANTS.

Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of **Cement Machinery**

42 NORTH 16TH STREET

::

PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

Northrup Bldg., Topeka, Kas.

Cement Engineers

Just Out

Architects' and Engineers' Hand Book on
**Reinforced Concrete
Construction**

ONLY ONE DOLLAR

CEMENT & ENGINEERING NEWS

22 Fifth Avenue, - - Chicago

MEDUSA WATER-PROOF COMPOUND

Makes all concrete watertight

Write for pamphlet describing its use. Do not accept a substitute, as there are many adulterated compounds on the market
It is not a wash, or an experiment



Illustration of Soulard Public Bath House, St. Louis, Mo. Pool, Floors, Steps and Walls surfaced with Medusa Pure White Stainless Portland Cement, containing Medusa Water-proof Compound.



Sandusky Portland Cement Company

Sandusky, Ohio

Write for free Sample of our White Portland Cement

Obtain our prices on Medusa Portland. Annual Capacity, 1,500,000 bbls.

IRON-ORE CEMENT

The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in place of Portland cement for all Marine Construction.

Send for Literature, Etc.

Worm-Cox Company
SOLE AGENTS

Marquette Building, Chicago

LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GROUND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.,
ALLENTOWN, PA.
Western Office:
725 ROCKEFELLER BUILDING,
CLEVELAND, OHIO.

ALPHA PORTLAND CEMENT...

Alpha, N. J.
Works: Martins Creek, Pa.
Manheim, W. Va.

Quality unexcelled The Recognized Standard American Brand Always Uniform
ALPHA PORTLAND CEMENT CO.
Manufacturers of but one grade—strictly straight Portland
General Office, EASTON, PA.

"The Earning Power of Your Dollar" Depends to a Great Extent Upon How Expended.

The wonderful opportunities we offer to buyers of Engines, Boilers and Kindred Lines, **DOUBLES** the purchasing power of your money. All our Machinery is of the latest models, is thoroughly overhauled and practically as good as new when it leaves our shops. Send us an inquiry.

ROCK CRUSHERS.

1—9 x 15 Allis Chalmers Jaw Crusher.

ROCK DRILLS.

6—Ingersoll-Sargeant Rock Drills, size 3 1/4 inches.
6—Ingersoll-Sargeant Rock Drills, size 3 1/8 inches.
Fitted for steam or air.

HOISTING ENGINES.

1—12x16 double cylinder, heavy duty LIDGERWOOD hoisting engine.
1—6x8 Marine Iron Works double cylinder, 5000 lbs. capacity, reversible steam chest.

PUMPS.

3—24 inch Centrifugal pumps, 2 to 3,000,000 gallons capacity.
1—20x13x12 Wheeler & Tappan Duplex Pump.
1—20x13x12 Cameron Single Acting Pump.
1—12x7x12 Smithvalve Duplex Pump.
1—8x12x12 Smithvalve Duplex Pump.
7—6x4x6 Dean Steam Pumps, new.
6—4 1/2 x 2 3/4 x 4 Dean Duplex Pumps, new.
8—3x2x3 Duplex Steam Pumps, new.

LOCOMOTIVES AND CRANES.

4—9x14 inches Baldwin, 36 inch gauge.
2—5 ton Brown Locomotive Cranes, 25 foot Booms.

IRON PIPE.

70,000 ft. 1 1/2 inch Standard Pipe, 35,000 ft. 1 3/4 inch Casing.
50,000 ft. 1 1/2 inch Standard Pipe, 40,000 ft. 3 1/4 inch Casing.
30,000 ft. 2 inch Standard Pipe, 60,000 ft. 3 3/4 inch Casing.
2,000 ft. 10 inch Standard Pipe, 8,000 ft. 5 5-8 inch Casing.
4,000 ft. 12 inch Standard Pipe, 9,000 ft. 6 1/4 inch Casing.
30,000 ft. 8 inch Cast Iron Pipe, 1,000 ft. 6 5-8 inch Casing.
300 ft. 24 inch Cast Iron Pipe, 1,250 ft. 8 1/4 inch Casing.
1,500 ft. Riveted Steel Pipe, 24 inch to 72 inch diameter.

5,000 rolls rubber, leather and canvas belting, structural iron, shafting, pulleys, couplings, steel wire and manila rope. Smoke stacks, corrugated roofing and siding, hose hydrants, tanks, and supplies of all kinds. We can save you money on anything you require.

SEND FOR OUR NEW 500-PAGE CATALOG NO. 962.

A wonderful book of facts and information of the utmost value to purchasing agents in all lines of business. Send for one to-day. It will cost you nothing.

Chicago House Wrecking Co.,

35th and Iron Streets, Chicago, Ill.

Colonial Trust & Savings Bank

A BANK FOR THE PEOPLE

Pays 3% on Savings Accounts

Capital and Surplus, \$1,106,620

YOUR ACCOUNT INVITED

205 La Salle Street, - - - - - Chicago, Ill

MEACHAM & WRIGHT CO.

Sales Agents

IMPROVED

UTICA HYDRAULIC CEMENT

And Dealers in

LEHIGH PORTLAND CEMENT

Telephone Main 59 206 La Salle Street, Chicago

F. D. MEACHAM, Pres.

F. S. WRIGHT, Vice-Pres

S. P. BLOUNT, Treas.

C. M. FOSTER, Secy

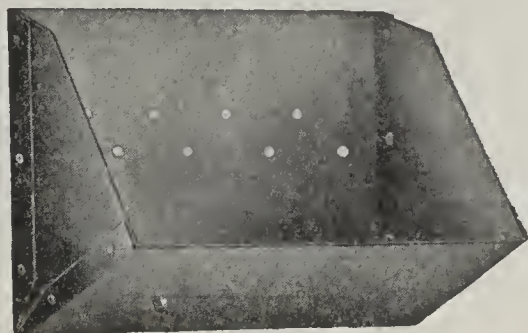
ELEVATING—CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys, Shafting, Shaft Bearings, Link Belting, Special Chains

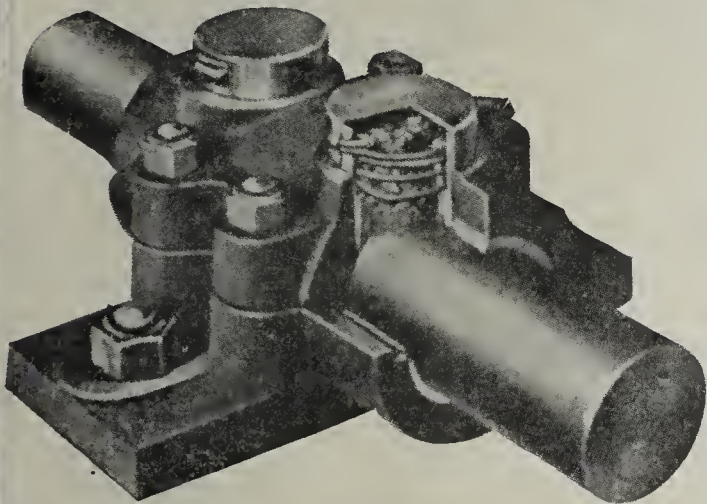


HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES.
Catalog for the asking.

SKILLIN & RICHARDS MFG. CO., CHICAGO

Your Coal Bill



Is something you constantly watch. If you could find an engineer who would save 10% you would pay him a large salary.

Did you ever stop to think that a reduction of friction throughout your plant, would reduce the amount of power necessary, hence a reduction in coal consumption?

You will of course admit that perfect lubrication would greatly reduce friction.

The new VAN DOREN LUBRICATING DEVICE is designed to give PERFECT LUBRICATION, and it DOES WHAT IT IS DESIGNED TO DO.

Your saving on oil, will in less than a year pay the cost of installation.

Your COAL SAVING is YOURS from the start.

Send for Complete Information.

C. J. VAN DOREN CO., 426 WEST MADISON STREET
CHICAGO

These are Weller-Made

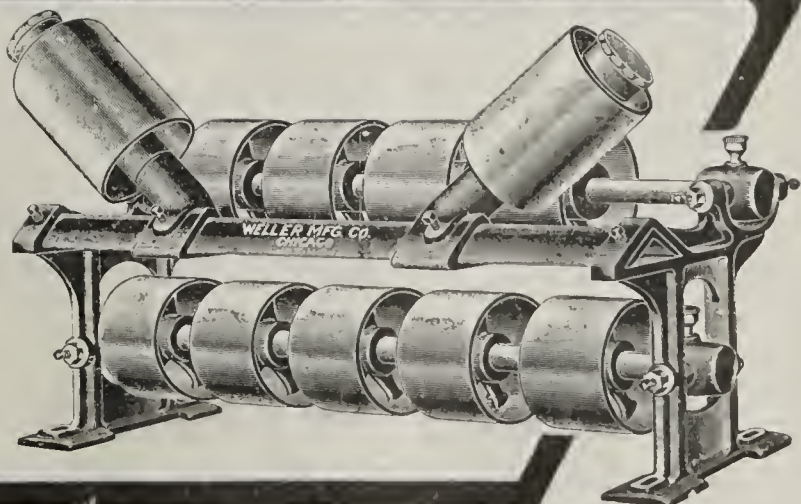
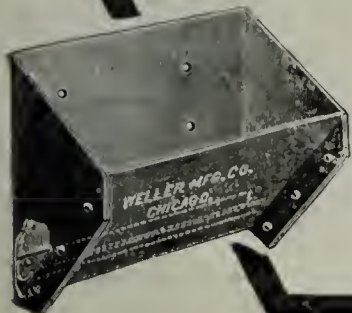
—and that is a guarantee wherein they are well made.

The Standard Combination Thoroughing Carrier Style B. is not only unique in construction because of its various good features, but it's a real money and worry saver to those upon whom devolves the maintenance of belt conveyors. Our catalog explains the "why and wherefore." You'd do well to write for it to-day.

The Heavy Steel Bucket illustrated is chiefly used in Cement Plants. Its curved inside bottom insures free delivery and is very desirable therefore, for handling certain classes of material. This bucket has supplanted the ones of malleable iron; its use is a proved value.

Write for our No. 19 512-page Catalog, showing complete line of Elevating, Conveying and Power Transmitting machinery. It's to our mutual benefit that you should have it. The catalog tells "why." Write to-day.

WELLER MFG. CO., CHICAGO





The Longest, Strongest and Best Stitched
Canvas Belt in the World

In Use Conveying Rock from the Quarry to the Mills of One
of the Largest Cement Plants in the Southwest.

Best on the market
Uniform in construction
You will like it

Applicable always
Limitless in its
Possibilities under
Hardest conditions
A stitched canvas belt

MANUFACTURED BY

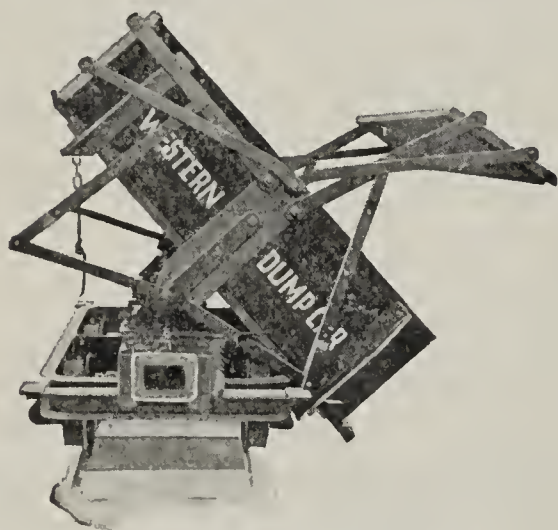
The American Belting Co.,
YOUNGSTOWN, OHIO

Chicago Branch: 161 LAKE STREET

Catalogue and Prices Upon Request

AGENTS EVERYWHERE

WESTERN DUMP CARS



1 1/4-yd. Car in Dumped Position

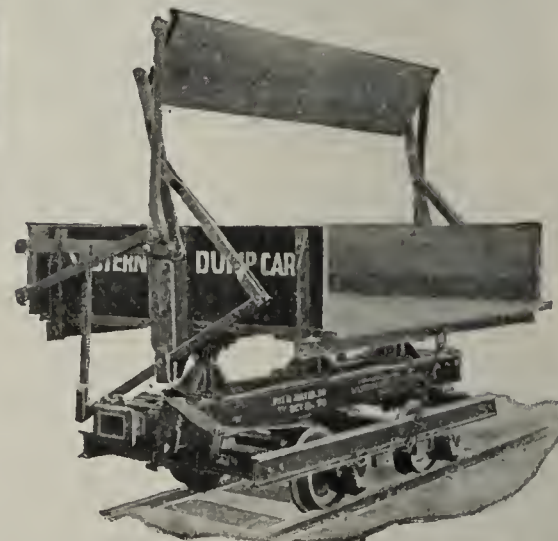
For handling cement, sand, strippings, etc., economically, there is nothing that can compare with the Western Dump Cars. They are made in all sizes from 1 1/4 yard on 2-ft. gauge, up to the heavy double truck railroad cars on standard gauge.

The low lift for the shovellers, the steep dumping angle, automatic side boards, high quality of material used in their construction, are a few of the many points which make the Western unequalled.

Western Wheeled Scrapers
Western Fresno Scrapers
Western Elevating Graders
Western Dump Cars

Aurora Dump Wagons

Western Drag Scrapers
Western Railroad Plows
Western Road Graders
Aurora Rock Crushers



1 1/4-yd. Side Dump Car with side board raised
ready for loading by hand.

Send for Catalog of Earth and Stone Handling Machinery

Western Wheeled Scraper Co.

Aurora, Illinois

Apparatus for Chemical and Physical Testing of Cement

EIMER & AMEND

205-211 Third Avenue, New York City

MANUFACTURERS OF

Chemical Apparatus, C. P. Chemicals and Reagents

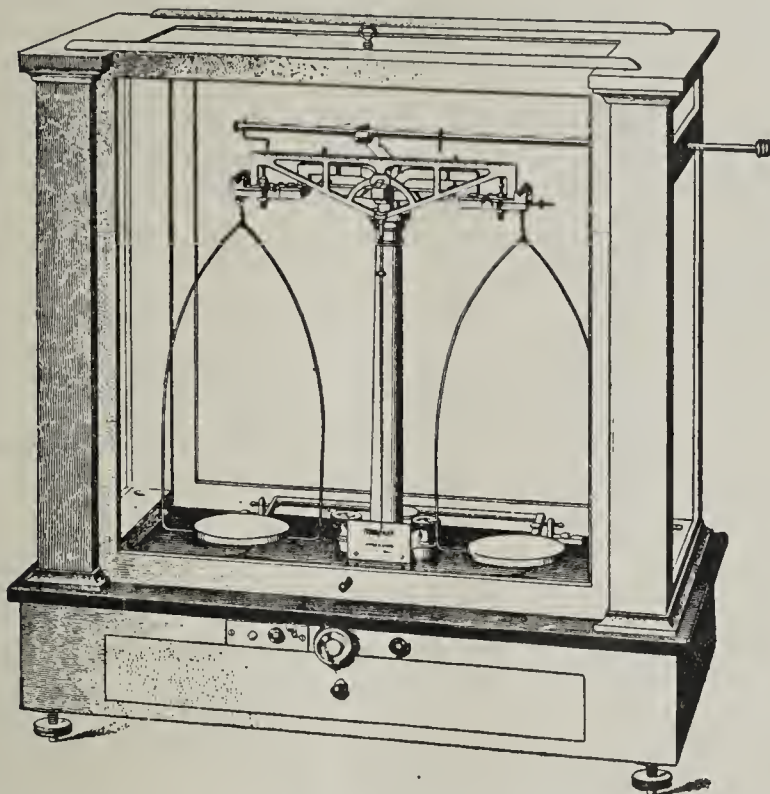
Cement Testing Machines.

Vicat's Needle.

Cement Briquette Moulds.

Gilmore Needle.

*Standard Sieves of Exact
Meshes.*



*Williams' Sp. Gr. Balance.
Specially adapted for determining
Sp. Gr. of Cement.*

(Descriptive Pamphlet sent on request)

*Schumann's, Le Chatelier's,
Jackson's and Candelot's
Apparatus for Sp. Gr. of
Cement.*

Filter Papers, C. S. & S. etc.

The "E. & A." Gold Plated Short Beam Analytical Balance

Capacity, 200 gm.; Sensibility, 1-20th mgr.

Perfect in Construction and Adjustment

Headquarters for

CALORIMETERS AND PYROMETERS

EMERSON FUEL CALORIMETER

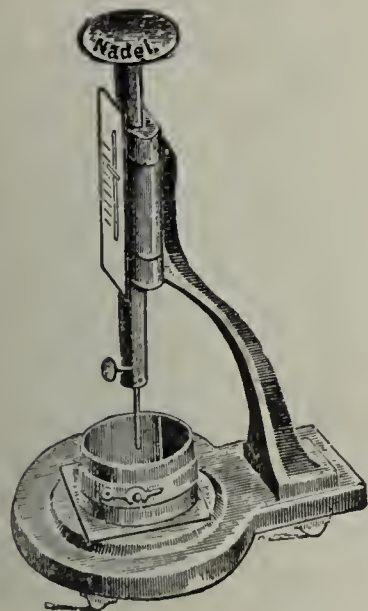
The most modern and efficient BOMB Calorimeter for accurate determination of the heating value of fuel. Specially constructed for use by the Steam Engineer as well as the Chemist

(Descriptive Booklet sent on request.)

WANNER OPTICAL PYROMETER

The most accurately reading instrument on the market. Simple in operation. Very Portable.

(Our large illustrated Catalogue gladly sent to Chemists on application.)





Dolese & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world.
Machinery throughout installed by us.

OLSON BROS. & CO.

Engineers and Contractors

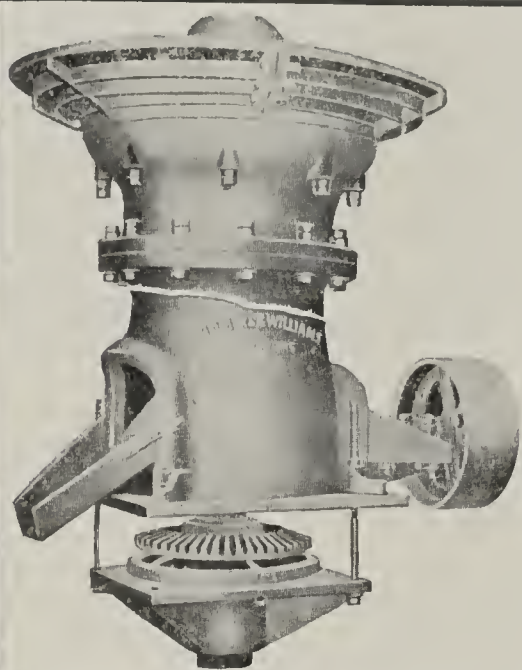
Cement Mill Machinery Erected, Stone Crushing
Plants Equipped and Erected. :: :: :: ::

ALSO COMPLETE PLANTS FOR HANDLING
COAL, SAND, GRAVEL, ORES, ASHES, ETC.

MODERN POWER TRANSMISSION
Elevating and Conveying Machinery.

Tanks and Vats, Especially In Connection with Machinery

2418-22 Bloomingdale Ave., Chicago



Kennedy Gyratory Crusher

The only Crusher built with a ball and socket eccentric which will lend itself to any change in the inclination of the main shaft. Improved hopper, more efficient dust collars.

— ALSO —

Cement Making Machinery

Kilns, Dryers, Tube Mills, Ball Mills, Elevators, Conveyors, Feeders,
Revolving Screens and Crushing Rolls.

Chalmers & Williams Inc.

1927 Commercial National Bank Building, - - - Chicago

120 Liberty Street, New York



TRADE MARK

PENINSULAR PORTLAND CEMENT

Acknowledged by competent Architects and Engineers
to be unequalled for fineness, wonderful development
of strength and sand carrying capacity.

"THE BEST IS THE CHEAPEST"

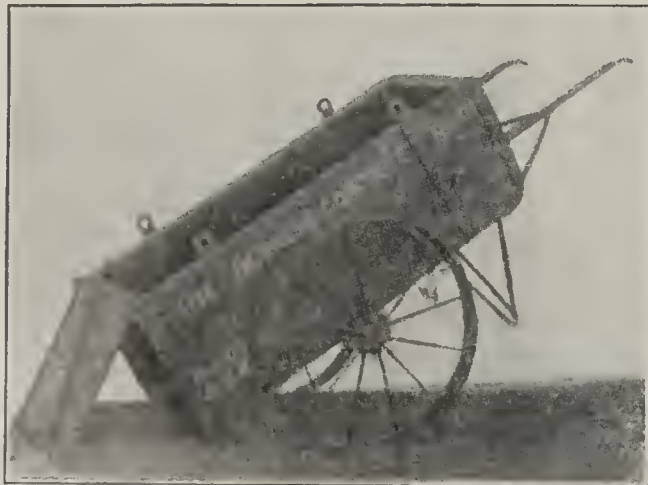
Address

Peninsular Portland Cement Co.
JACKSON, MICHIGAN.

Fire Brick Linings For Cement Kilns

STANDARD TESTING SAND AND
GENERAL BUILDING SUPPLIES

Garden City Sand Co.,
188 Madison St., Chicago



CAPACITY 1/4-1/2 YARD

The Burness PATENTED Concrete Truck

FOR—

Handling aggregate to mixer.

"Mix" concrete to forms, oper-
ated by two men on lever
and to hoist.

F. B. BURNES,
SCARRITT BLDG.
KANSAS CITY, MO.



THE BURNES PATENT BRIDLE ATTACHED TO THE BUR-
NESS PATENT CONCRETE TRUCK ON BOOM DERRICK

Why Don't You?

Make Your Own Cement in the manufacture of SILICATE BRICK and STONE out of Sand, Slag, Quarry-Waste, or any salicious material, with a small percentage of LIME.

Our "DIVISION-METHOD" will produce a higher grade product at a lower cost than can be made under any other process.

"RAW MATERIAL TO FINISHED PRODUCT—24 HOURS."

We furnish all Machinery, erect complete Factory and turn it over in perfect running order.

Write for full particulars to

International Sand-Lime Brick & Machinery Co.

90 WEST STREET, NEW YORK CITY

ENGINEERS AND CONTRACTORS FOR SILICATE BRICK AND STONE FACTORIES.

The Right Power For Concrete Workers

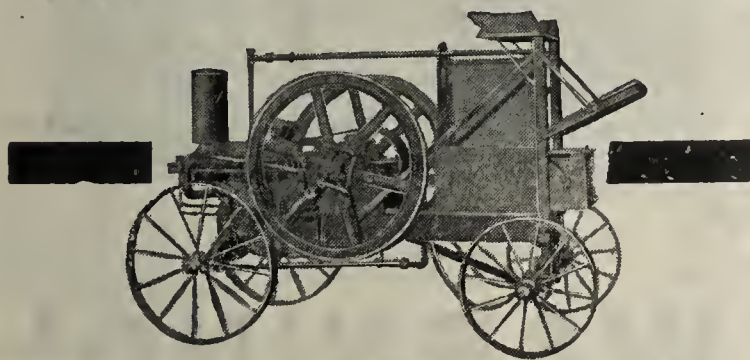
YOUR engine is in the I H C line. For you want greatest efficiency, combined with economy, simplicity, strength and durability. Your engine must work hard, in all kinds of weather, under the most trying conditions. That is why

I H C Gasoline Engines

have been the choice of concrete workers who want the right power. See the local International agent about the I H C engine to meet your requirements. Any horsepower, vertical or horizontal, stationary or portable, air or water cooled, mounted on skids or trucks. Catalogue and full information from agent or direct from us.

International Harvester Company of America

41 Harvester Building. INCORPORATED CHICAGO, U. S. A.



CHARLES F. MCKENNA, Ph. D.

Inspection of Cement

and all other Engineering Materials. Examination of Properties and of Economical Operation of Works.

Consulting and General Practice in
Chemistry, Technology, Chemical
Engineering and Chemico-
Legal Cases.

Long Distance Telephone.

Cable Address: PLAT PEARL

Laboratories: 221 Pearl St., New York City

Offices: 50 Church Street



OFFICES

- BIRMINGHAM
- BOSTON
- BUFFALO
- CHICAGO
- CINCINNATI
- DENVER
- DULUTH
- HAZLETON
- HOUGHTON
- HUNTINGTON
- JOPLIN
- KANSAS CITY
- MEMPHIS
- MEXICO CITY
- NASHVILLE
- NEW ORLEANS
- NEW YORK
- PHILADELPHIA
- PITTSBURG, PA.
- PITTSBURGH, PA.
- PORTLAND
- SALT LAKE CITY
- SAN FRANCISCO
- SCRANTON
- SEATTLE
- SHREVEPORT
- SPOKANE
- SPRINGFIELD
- ST. LOUIS
- TERRE HAUTE

MONOBEL is an
ideal explosive for
dry QUARRIES. It is
exceedingly valu-
able in cold weather
because it does not
require thawing.

1802
1910

EXPLOSIVES



E. I. DU PONT DE NEMOURS POWDER CO. Wilmington, Del., U. S. A.

COPYRIGHTED BY E. I. DU PONT DE NEMOURS POWDER COMPANY, 1910

Hotel Cumberland

NEW YORK

S.W. Cor. Broadway and 54th St.

Near 50th Street Subway Station and 53d Street Elevated

HEADQUARTERS FOR THE CEMENT
AND MACHINERY MEN.

New Modern Fire Proof

All Outside Rooms. No Carpets. All Oriental Rugs.

Transient Rates \$2.50 with Bath and up.

10 minutes walk to 20 theatres.

Send for Booklet.

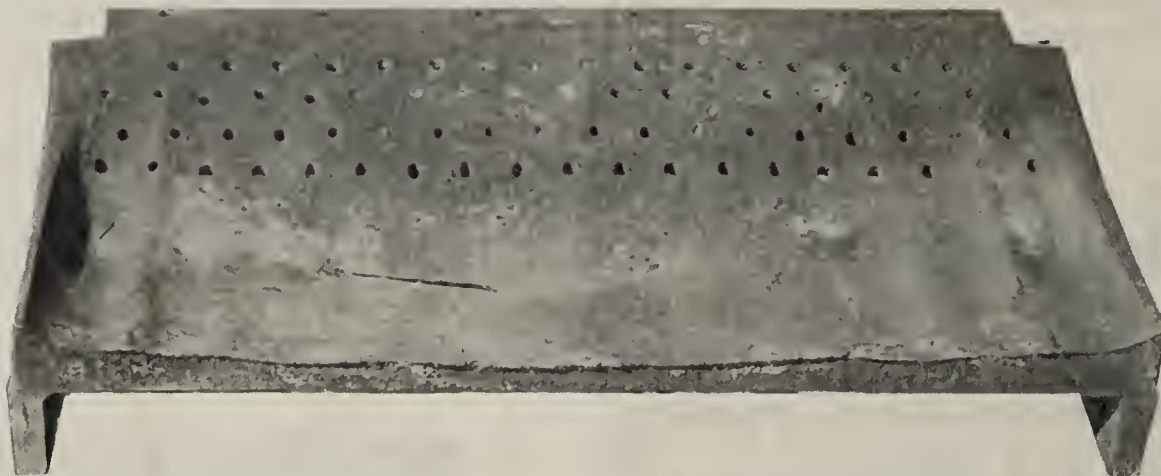
HARRY P. SIMPSON, Formerly with Hotel Imperial.

R. J. BINGHAM, Formerly with Hotel Woodward

TISCO APPLICATIONS

INVARIABLY SHOW ECONOMY IN THE FIELD OF WEAR AND TEAR

WE SOLICIT
A TALE
OF
YOUR
TROUBLES.



There are
ofttimes hard
places that are
weak spots
even in the
best cement
plants.

For the same money the Ball Mill Plate above ground approximately 228,000 barrels more clinker than the plates which it replaced.

TISCO applications in single mills have established economies as high as one and three-eighths cents per barrel.

MANGANESE STEEL CHAINS

Elevating
GRIT PROOF
INDESTRUCTO

Power
Transmitting
WEARLESS

Conveying
STRAIGHT LINE
RIVETLESS

RECOMMENDED APPLICATIONS FOR

STEAM SHOVELS
CRUSHERS
BALL MILLS
FULLER MILLS
KENT MILLS

TUBE MILLS
KOMINUTERS
RAYMOND MILLS
PULVERIZERS
CONVEYORS

BONNOT MILLS
SPROCKETS
CAR WHEELS
SCREENS
GEARING

Taylor Iron & Steel Co., HIGH BRIDGE, New Jersey

Toch's Cement Filler

(Patented)
AND

Toch's Cement Floor Paint

(Patented)

Unfinished floors wear rapidly, producing dust which gets into machinery, causes sparking on dynamos, and injures merchandise.

Toch's Cement Filler is a unique patented compound used to fill the pores of the cement and prevent abrasion.

The surface is finished with Toch's Cement Floor Paint, which is made in six standard shades, or other colors if desired.

Toch's Cement Filler need never be replaced. The finishing coat of Toch's Cement Floor Paint will, of course, need occasional renewal, according to the amount of wear.

A cement floor thus finished has a Smooth, Durable Surface, is not slippery, does not "dust," is oil-proof and waterproof, and is cleaned as easily as enamel.



Toch's Cement Filler and Floor Paint in L. I. R. R. Power House, New York City.

WARNING!

To Paint Manufacturers, Paint Jobbers, Painters and all interested in Concrete and Cement Protection.

Our Cement Filler and Cement Floor Paint are FULLY PROTECTED BY PATENTS, and makers and users are WARNED AGAINST INFRINGEMENT. We were the first to determine that organic acids would neutralize the free alkali in cement floors and have for some years been marketing our Cement Filler and Cement Floor Paint. Since these materials have been successful, a number of imitations have sprung up, and we warn the trade that our patents are such that we will prosecute both manufacturer and consumer.

Toch Brothers' Cement Filler and Cement Floor Paint are applied to concrete floors for waterproofing, dustproofing and oil proofing, and for the prevention of disintegration. We are prepared to grant licenses, but will prosecute to the utmost any infringement or imitations.

Toch Brothers

Specialists in the Manufacture of Technical Paints.
Established 1848.

320 Fifth Avenue, New York.

710 Chamber of Commerce
Building, Chicago.

24 South 7th Street
Philadelphia.

When You Sit Down To Figure The Dollars Saved In A Concrete Mixer

IT'S not the first cost that's important but how soon the investment has been returned.

—There's the up-keep, the quantity produced, the quality of mixing and the saving in the pay roll when pay day comes.

—Quality in a mixer pays dividends when initial cost is forgotten.

But it costs just as much to build a mixer embodying the ideas in mixing of 5 or 10 years ago as it does the best mixing practice now.

It's not what you pay but what you buy that counts.

Here's an epitome of the fulfillment of present day mixing you buy in the

Koehring Concrete Mixer

The heaviest drum on any mixer—greatest strength in the most important wearing part.
Three independent, positive mixings in the one drum—most rapid mixer made.

Trunnion rollers placed close to ends to give drum great stability.

Rollers cast with broad faces and chilled as hard as tempered steel.

Double-gear drive close to ends equalizing uneven strains.

Charged direct from barrows on a level with the ground.

No elevated runways of any kind required.

Simplest charging elevator on any mixer.

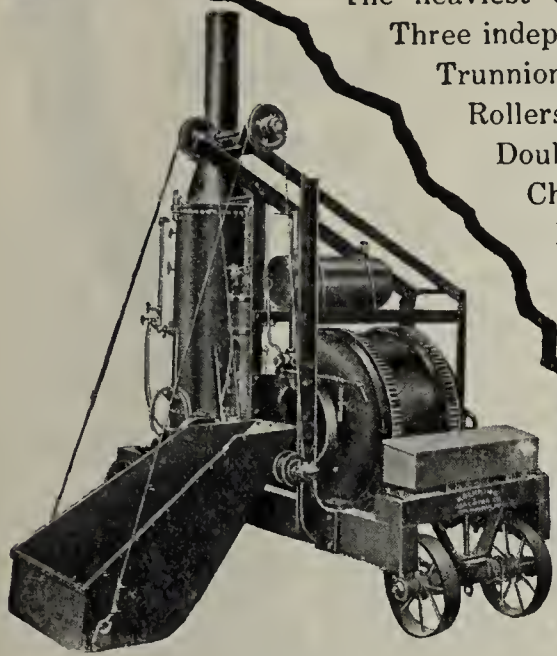
Discharge chute does not interfere with barrows.

Discharge always under perfect control.

Discharges by simply raising inner end of chute.

Equipped with steam, gasoline or electric power.

A card will fetch the catalog: mention "Catalog B."



Koehring Machine Co.

614-616 Germania Bldg., Milwaukee, Wis., U. S. A.



None Just as Good

ATLAS PORTLAND CEMENT

produces uniform work of the best quality. It is not good in one spot and bad in another. It produces a building as permanent, lasting and durable as stone. It gives you a one-piece house, every inch of which is fireproof and sanitary. Be sure you get the right cement—Atlas—the cement of which the United States Government bought 4,500,000 barrels for use in building the Panama Canal.

Send for these Books:

Concrete Houses and Cottages, Vol. 1—Large Houses\$1.00
Vol. 2—Small Houses 1.00
Concrete Country Residences (out of print) 2.00
Concrete Cottages (sent free)
Concrete Construction About the Home and On the Farm (sent free)
Reinforced Concrete in Factory Construction (Delivery Charge).... .10
Concrete in Railroad Construction 1.00
Concrete in Highway Construction \$1.00 Concrete Garages (sent free)

THE ATLAS PORTLAND CEMENT CO.

Dept. 3, 30 Broad St., New York

Largest Output of Any Cement Company in the world—
Over 50,000 Barrels Per Day.



BELT CONVEYORS

[For Use in

Cement Plants

Have No Equal

We have some interesting data on this subject which is yours for the asking.

Robins Conveying Belt Co.

THOMAS ROBINS
President

Passaic, N. J. G. KEMBLE BALDWIN
Chief Engineer

NEW YORK

CHICAGO

"Pioneer"

"Safest to use, because richest in Bitumen"

OUR asphaltic products were first introduced in 1896. For 14 years they have been undergoing the hard practical tests of every day use, and Engineers of repute in all parts of the United States are specifying "Pioneer" Asphalt materials today, because these materials have proven superior to all others.

Wherever there is a reservoir to be waterproofed specifications should be adopted which will prohibit the use of an inferior grade of asphalt. Wherever pipe line construction is in progress the question of *protection and preservation* of the pipe ought not to be decided upon mere claims, but the rigid demands of *specifications that are safe* should be enforced as a check upon lax methods and inferior materials.

"Pioneer" Reservoir Waterproofing Asphalt "Pioneer" Mineral Rubber Pipe Coating

Here are two commodities that will meet the demands of the specifications suggested. They are not experimental, but have both been used with the highest success for years, and under the severest conditions.

Over 99½% Pure The superior quality of our asphalt is a *proved-out* proposition—a *known quantity*. Our own mines in Utah contain immense deposits of the purest hydro carbon known, our Gilsonite analyzing over 99½ per cent pure bitumen. In any true technical comparison of values "Pioneer" Mineral Rubber Pipe Coating and "Pioneer" Reservoir

Waterproofing Asphalt will readily demonstrate the superiority which has made them practically non-competitive. **Specifications** Send for our specifications and be safeguarded against those asphalt (which are offered as being equal to "Pioneer") the employment of which has, in spite of claims, proven them to be inefficient.

The American Asphaltum & Rubber Co.
600-614 Harvester Bldg.,
Chicago, Ill.

**A
14
Year
Record
of Success**

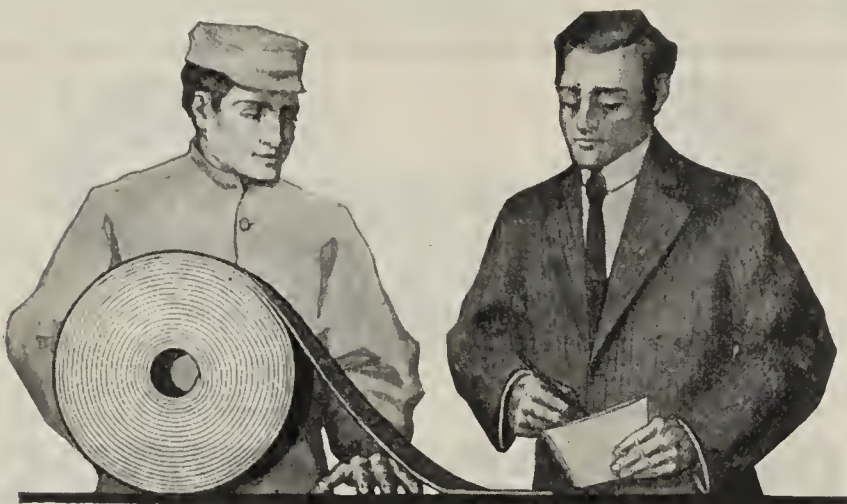


FIGURE THE COST

If one Reliance belt lasts twice as long as two ordinary belts and costs only a trifle more to *buy*, besides giving greater efficiency, needing few if any repairs and causing no trouble, which is the most economical belt to use?

RELIANCE Guaranteed Leather Belting

is the highest quality made. We recommend it especially

For Cement Plants

where it does the severest work without stretching or quickly wearing out. Our broad experience will prove of value to any manufacturer seeking utmost durability and efficiency. Where a waterproof belt is necessary Sea Lion will prove highly satisfactory—we *guarantee it*.

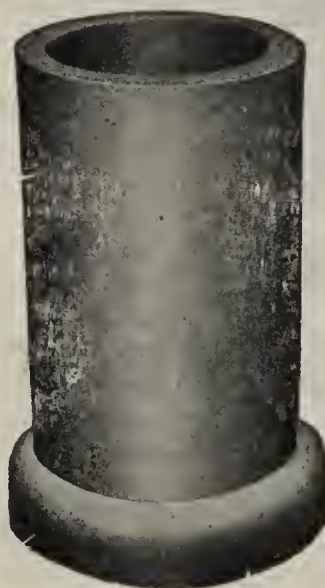
Write for Booklet.

Chicago Belting Company
12-22 Green St., Chicago

Branches: New Orleans, 431 Gravier St. New York, 71 Dey St.
Portland, Ore., 94 First St. Philadelphia, 234 North Third St.



Cement Sewer Pipe Is the Large Profit End of the Concrete Business



Miracle Cement Pipe Molds have been in general use throughout America and many foreign countries for the past five years, and are giving universal satisfaction. Within the past three months large plants have been equipped for the manufacture of cement pipe by the use of Miracle molds in the cities of Denver, Tacoma and Seattle, which cities have opened their specifications to the use of cement sewer pipe.

Special Sewer Pipe Catalog (Just Out.)
New Mixer Book (Just Out) Get one.
Sent FREE to readers of this Magazine.

MIRACLE PRESSED STONE CO.

Department "L."
MINNEAPOLIS, MINN.

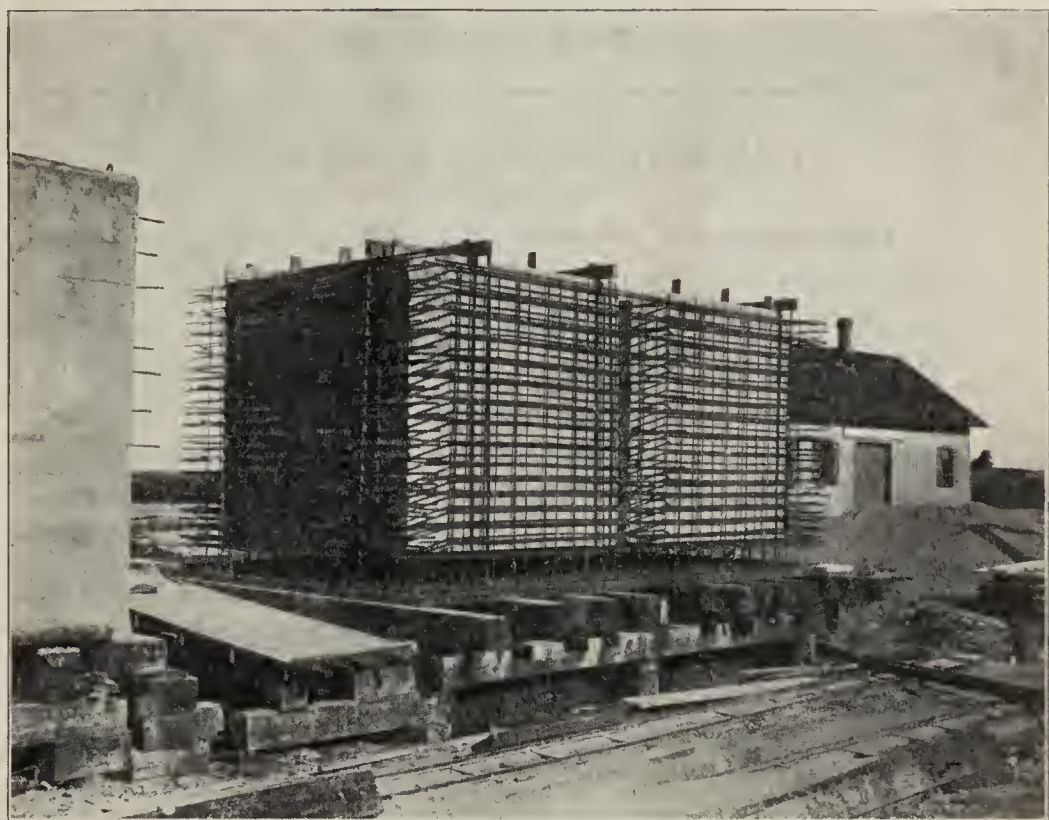
CEMENT

.....AND.....

ENGINEERING NEWS



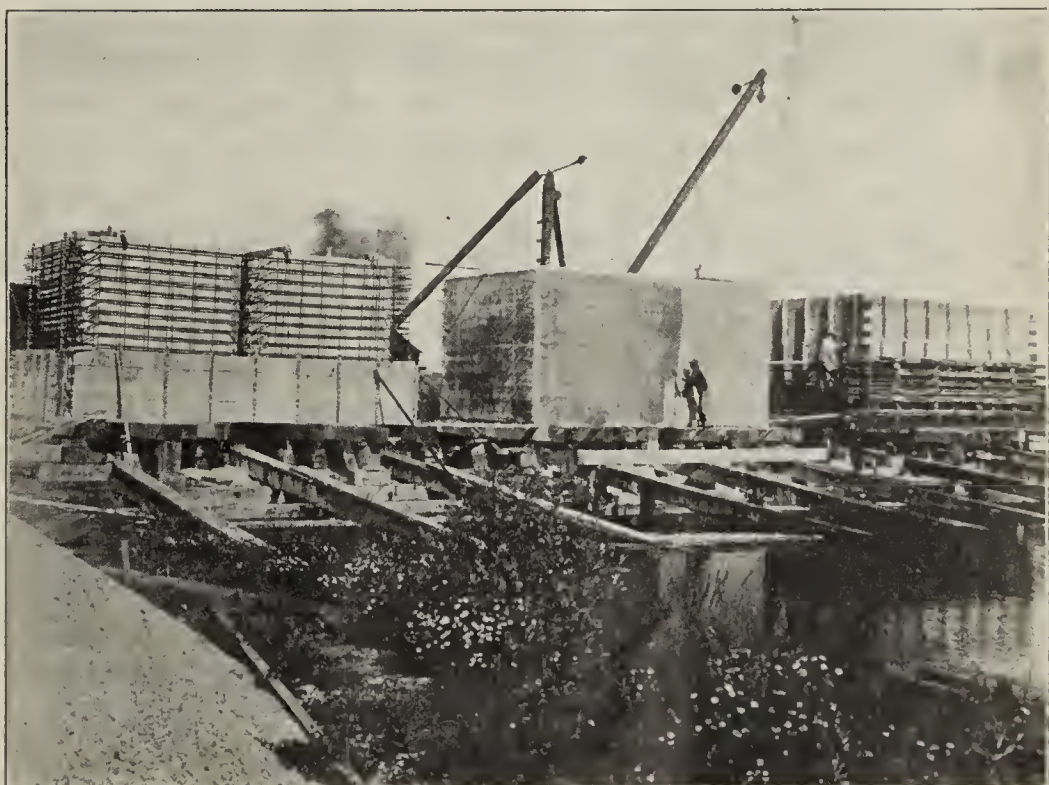
View 1.
Reinforced Concrete Caissons for Algoma
Breakwater—ready to launch.



View 2.
Reinforced Concrete Caissons under construction.



View 3.
Reinforced Concrete Caissons under construction—rear view.



View 4.
Reinforced Concrete Caissons under construction,
and ready to be launched.

CEMENT AND ENGINEERING NEWS

[PUBLISHED MONTHLY]

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue

Cable Address—"Seaferts" Chicago.

Entered at the Post Office at Chicago, as Second-class matter, July 21, 189 under Act of March 3d, 1879.

Subscription	\$2.00 Per Year
Foreign Subscription	\$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON	Advertising Manager
---------------------------	---------------------

CHICAGO, MARCH, 1910.

THE CHICAGO CEMENT SHOW.

The exhibition of cement products and of concrete machinery, which took place during the time of February 18-26 at the Coliseum, was a complete success from every point of view; it was a great improvement over the preceding expositions, which were confined almost entirely to concrete mixing machinery and to the manufacture of concrete blocks. The former two cement shows, therefore, offered points of interest only to a limited number of visitors, whereas most of them found it extremely tiresome to go over the various exhibits deviating only slightly in design and to listen to the claims of the manufacturers of the numerous types of concrete mixers and block moulding machinery.

With the former rather unsuccessful attempts at a cement show in mind, the present year's visitor could not help being agreeably surprised at the view which unfolded itself before his eyes. The picturesque surroundings undoubtedly had a great deal to do with making him forget at once the businesslike methods of the former expositions of exhibiting common-place machinery. This show, for the first time, was a comprehensive review of all branches of cement manufacture, cement products and cement construction, and was an excellent illustration of the rapid progress made during the last year in the application of cement. As superior as this third cement show was compared to the first of several years ago, as widely the use made of cement differs today from that of former years. At this time there was something of interest for every visitor, no matter in what branch of "cementology" he may have been engaged, and even outsiders were well repaid for the time they spent on the grounds and had to admire at least the artistic uses to which cement could be put according to the samples exhibited.

There was the same endless array of concrete mixers and block moulding machines of former shows; there were concrete blocks and concrete brick of every description. The various waterproofing compounds were exhibited in a convincing manner, and concrete construction received its due share in a number of

interesting exhibits of reinforcing steel of different styles and designs. Even the manufacturers of machinery for cement plants occupied considerable space, while most cement manufacturers, with offices in Chicago, entertained well-equipped headquarters at the show, and, last not least, Art was represented at this exhibition in a manner entirely novel to most consumers of cement. This was bound to have a cheerful influence upon the mind of every cement man, and must have filled the heart of every concrete contractor with joy and certainly convinced all sceptics, that the time had come at last, when the builder would make use of concrete in a manner pleasing to the eye and when architects would place within the reach of the man of average means, at a reasonable cost, stone-built houses which do not lack the artistic features of the residences of the rich, namely, by substituting for the polished or hewn granite imitations of concrete, by the use of which masters in this art are able to attain the same beautiful effects.

Among the most noteworthy and novel features of the exposition we count the laudable efforts made by manufacturers of reinforcing steel, who, by their exhibits, and by their publications, gave this cement show an aspect differing entirely from preceding expositions. While formerly only designs and methods of construction within the scope of the small builder were exhibited, this elaborate exhibition offered brain-food to the scientifically trained engineer as well as to the side-walk layer or concrete brick-maker. Constructions on a small scale of floors and of columns were admirably carried out, and test loads were applied to them. Methods of safe construction were explained by models of various stirrup systems applied to beams and of Considere's spiral reinforcement in connection with columns and girders. This exhibit was highly appreciated on account of its great educational value.

The manufacturer of waterproofing compounds had done his best in order to make plausible to the builder that concrete had to be either very rich in cement or that it necessitated admixtures of preparations which closed the pores and made the concrete impervious to water. The most interesting tests in this line (some of them making use of extraordinarily high pressures), were carried on by the National Waterproofing Co., Geo. W. DeSmet Co., the Ceresit Waterproofing Co., and by the Hydrolithic Cement Co. In addition to the tests, their publications showed that they had used their waterproofing systems in a great number of important constructions, which, furthermore, emphasized the value of their compounds.

The concrete block and concrete brick manufacturer made every effort conceivable to imitate other building material, be it granite or other kinds of cut stone or even pressed clay brick of the shades and ornamental effects most desired by architects. As comic as this hiding of the unsightly features of the ordinary cement wall may appear to the impartial observer, the advocates of artistic design will surely

welcome a similar application of cement. The time has passed, when the cement dealer could make the builder believe that a gray cement wall was a decoration suitable for anything better than factories or prison walls. The architect, fortunately, compelled the builder to look out for more appropriate designs, and to recommend cement in a rejuvenated form. To these efforts we owe an entirely new method of making use of cement. While about five years ago only now and then attempts were made at imitating the many varieties of granite, as for instance during the erection of the Chateau by Krottnaurer, the trend of the last years has been entirely along these lines. The trowelled wall made room to the "splatter-dash coat," and this in turn was replaced by a "stone-kote," or whatever names experts in this business, as Mr. Rose and Mr. Curtis of the Garden City Sand Co., may give to their latest creations. The concrete block manufacturer has improved his product in identically the same directions as the exhibits of the Ideal Concrete Block Machine Co., the Century Cement Machinery Co., the Diamond Concrete Machinery Co., and the Fisher Hydraulic Stone & Machinery Co. showed. Granite grit has taken the place of sand, and beautiful, really ornamental, work is being done, instead of the former moulding of unsightly concrete brick and block, which builders refused to buy any longer, and which, for this reason, are now lying unused in the yards of the manufacturers by the millions.

The improvements mentioned so far referred to exterior decorations of residences. But, also for interior ornaments of the highest order, for sculptural work for porches and for landscape gardening, Portland cement concrete has proven to lend itself to the most artistic treatment, as the beautiful exhibit of the Atlas Portland Cement Company revealed, which surpassed everything done in concrete heretofore. No one but an expert in building materials would have been able to tell that the superb balustrades executed in various shades of red and pink granite and in the most delicate tints of sandstone were merely imitations, and, in the same way, it was almost impossible to distinguish the imitations of polished granite in the form of fountains, monuments and garden seats from the real material. That such work can be done merely by making use of cement, sand and crushed stone must undoubtedly inspire every one engaged in ornamental work with the unlimited possibilities of this most modern building material—Cement. Of course it takes experts to do such work,, just as well as clay or marble become ornaments only through the sculptor's touch. Fortunately, we have such artists in our midst, as for instance the Decorators' Supply Co., the Art Marble Co., Professor Rowley and others, who are champions in the artistic uses of cement.

To make the exposition of cement products complete, cement roofing tiles, cement paints and even contractors' supplies, as derricks, dump-cars, and so on, were exhibited in an attractive manner.

Taking the exposition as a whole from all points of view, it must have made a profound and lasting impression upon the minds of every person who attended it, as so many expressions of praise were uttered in behalf of the management.

PLASTER, OVERBURNT GYPSUM AND HYDRAULIC GYPSUM.

By M. Glasenapp.

An essay, describing the various products obtainable by heating and calcining of native gypsum, based upon an extensive microscopical research, intended to throw light upon the excellent properties of some kinds of burnt gypsum and to end the confusion existing in the classification of gypsum products. Illustrated with numerous photographs of microscopic sections.

Translated by Dr. W. Michaelis, Jr.

(Copyrighted 1910, by William Seafert.)

(Continued from page 55.)

III. HYDRAULIC GYPSUM:

During the last years several papers dealing with hydraulic gypsum have been published. The most noteworthy of them are those by van't Hoff and by Rohland. Nevertheless, its nature, which van't Hoff declares to be "quite mysterious," has not been explained by these contributions. Scientific investigation and practical experience led to a number of contradictory points, so that this subject had still to be regarded as an unsolved problem.

According to the statements found in the most recent literature on hydraulic gypsum (floor-gypsum, flooring-plaster), this modification of calcined gypsum may be briefly summed up to be an anhydrite of gypsum, calcium sulphate, which "under the microscope in nitric acid shows the needle-crystals of the half-hydrate," which "has the same composition as the soluble anhydrite and therefore must be regarded as an isomorphous modification of it," which, furthermore, "forms between the temperatures of 400 and 600 centigrade" and "possesses the remarkable ability not to assume the temperature of its surroundings, if the latter surpasses 600 centigrade" and which ultimately "dissolves in the water with which it is mixed in the same manner as plaster of Paris, though more slowly, and crystallizes as di-hydrate."

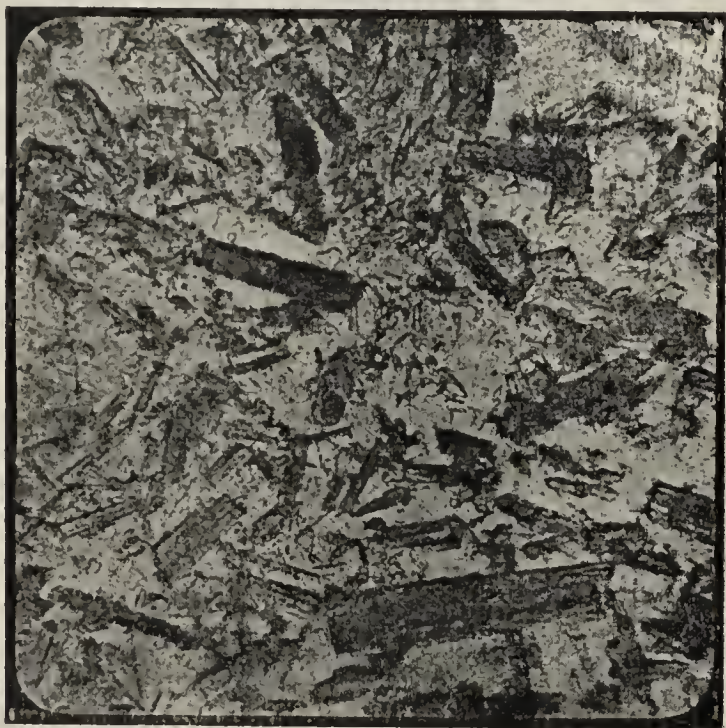
The following description of carefully conducted investigations will show how far the real properties of hydraulic gypsum differ from the above summary from modern literature:

Hydraulic Gypsum Under the Microscope:

Van't Hoff's and G. Just's publication "The Hydraulic Gypsum or So-Called Floor-Gypsum" contains a micro-photograph of a sample of gypsum which the authors believed to represent hydraulic gypsum. However, my microscopical examinations of a number of samples of undoubtedly genuine hydraulic gypsum entitle me to make the statement that the product, which formed the basis for the research-work of these experimenters, was by no means hydraulic gypsum. The micro-photograph published by them (see cut No. 8), as well as the properties of the gypsum which they describe convince me that the manufacturer supplied them not with hydraulic gypsum, but with a sample of "overburnt" gypsum, slow-setting plaster, so-called I. anhydrite, which hardened fairly well, though slowly. It must have been gypsum burnt at a temperature between 250 and 300 centigrade as described in the preceding chapter. The structure of the fragments of their sample (Cut No. 8) indicates that a fibrous raw gypsum was used for its manufacture, which, after having been ground, yields needle-shaped and prismatic crystal fragments.

That their sample was merely slow-setting plaster can, furthermore, be inferred from the remark by the authors that its capacity to harden was found to be decreased and the time of setting retarded after it had been heated at a temperature of 400 centigrade for 10 hours. From this they rightly concluded that their sample was burnt at a temperature below 400 centigrade. A similar behavior, however, can only be discovered in the case of the above described slow-setting gypsum, but is not characteristic of hydraulic gypsum, which is obtained only at temperatures far above 400 centigrade, as will be shown later, and upon which heating at 400 centigrade has no influence whatever.

This confounding of hydraulic gypsum and slow-setting plaster is easily explained by the fact that in commerce these two kinds of gypsum are frequently not properly distinguished one from the other and that the hardening process of both of them shows this resemblance that it is completed only after weeks and months, which plainly distinguishes them from common plaster. Unfortunately, however, van't Hoff's publication, describing a gypsum with entirely different properties, has been widely quoted and thus has spread a wrong conception of the method of production and of the properties of hydraulic gypsum. Also Rohland has been influenced by it; as a consequence, the latter's publication does not contribute anything towards explaining the actual properties of hydraulic gypsum; on the contrary it makes the confusion even greater.



No. 8. Slow-setting plaster. Micro-photograph taken from van't Hoff's and Just's publication. By them believed to be hydraulic gypsum or floor-gypsum.

Remarks by the Translator:

The American reader can best obtain an idea of the confusion existing in the classification of gypsum products and of the unreliableness of statements to be found in modern literature by referring to the fourth chapter of Edwin C. Eckel's book on "Cements, Limes and Plasters," which contains a translation of the above mentioned publication by van't Hoff and Just.

Also Eckel quotes van't Hoff with the greatest reverence. He divides the gypsum products obtainable at higher temperatures than customary for the burning of plaster of Paris into two groups, "Flooring-Plasters" and "Hard-Finish Plasters," and gives the first name to all grades of gypsum "prepared by simple burning at high temperatures" and the second

to those "produced by a double-burning with the additional use of chemicals."

He continues: "Neither, product is made to any extent in the United States, though a considerable quantity of hard-finish plasters are imported every year. The data obtainable as to processes of manufacture are scanty, and the descriptions published are often contradictory, so that it has been difficult to prepare a satisfactory account of these products. It is believed, however, that the descriptions given below contain no errors of importance."

"The flooring-plasters ('Estrichgips' of German reports) include those plasters made by calcination of a relatively pure gypsum at temperatures of 400 Fahrenheit (equal to 200 centigrade) or higher."

"In the literature of gypsum and plaster it is often stated that gypsum, burned at temperatures exceeding 400 Fahrenheit, yields a completely dehydrated product—an artificial anhydrite—which is entirely valueless as a structural material, because it has completely lost its property of recombining with water. This statement is, however, erroneous, for plasters burned at such temperatures are regularly made and used. They set with extreme slowness, however, and require very fine grinding."

"Until very recently no satisfactory discussion of this phenomenon had been attempted, and the few published accounts of the manufacturing processes employed were contradictory as to temperature reached, composition of product, etc. Fortunately, however, a detailed account of the chemical changes involved was published during 1903 by van't Hoff in the Transactions of the Berlin Academy of Sciences. As this paper is practically inaccessible to the American engineer or manufacturer, a translation is here appended:"

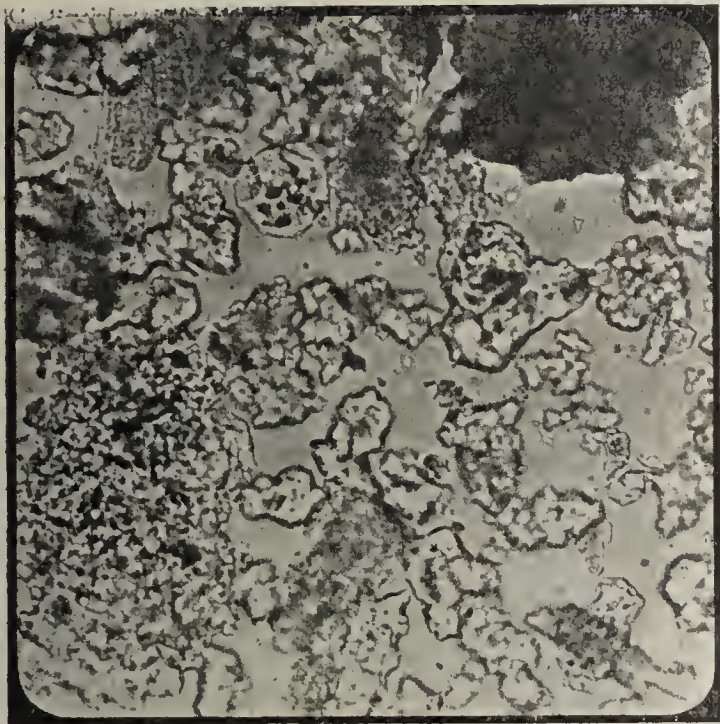
Then follows van't Hoff's and Just's publication on "The Hydraulic Gypsum or So-Called Floor-Gypsum," which, as demonstrated by Glasenapp, refers to a gypsum burnt below 400 centigrade, to a slow-setting plaster, whereas hydraulic gypsum, or the floor-gypsum of commerce, is obtained only at temperatures above 750 centigrade. Van't Hoff concludes his paper as follows:

"The essential result of the investigation, therefore is, that in the heating of gypsum after total dehydration, which occurs at about 190 centigrade, the capacity to bind water is at first retained, and is only gradually lost, either by more intense or by longer heating. The retention of the crystalline form, which is probably due to burning without previous division into small bits, checks this so-called dead-burning, and is therefore of technical importance. We found no evidence to support the statement that, after dead-burning, a new binding capacity appears at a high temperature, in which case even the natural anhydrite would be suitable for burning floor-gypsum."

In the face of this meagre information available and involuntary misrepresentation on the part of van't Hoff, the reader of Glasenapp's present publication must necessarily admire the thoroughness of his research-work and be thankful to the experimenter for the large amount of data and information supplied. This paper, in my opinion, will elucidate the confusion that existed heretofore and will give rise to a number of additional essays until finally manufacturer, consumer and inspecting chemist will be equally educated on the subject and will all be convinced of the merits of the higher grades of gypsum, namely slow-setting plaster and hydraulic gypsum.

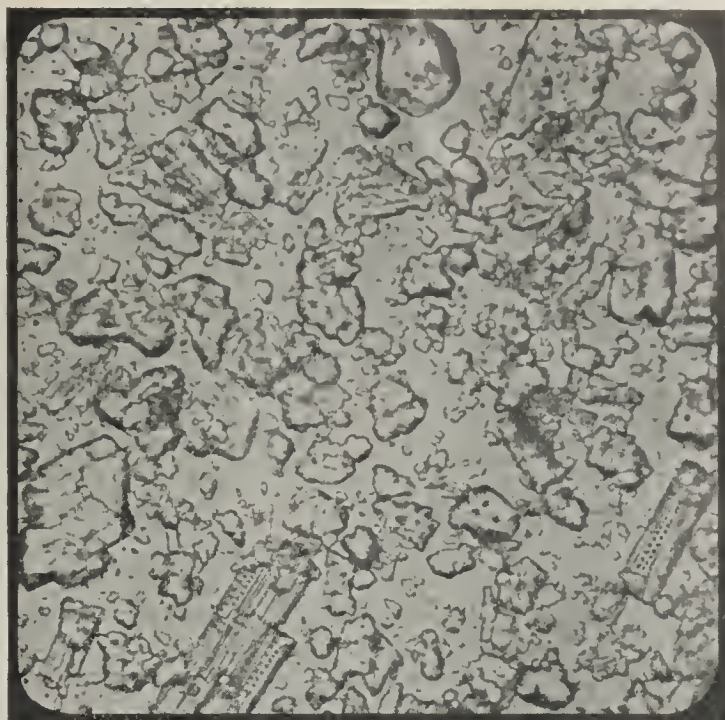
We now return to Professor Glasenapp's paper:

The literature on hydraulic gypsum contains frequent references to "crystals of the half-hydrate." To this I must remark that the half-hydrate constituting plaster of Paris does not possess a crystal shape of its own; what we see under the microscope are the crystal fragments of the partly dehydrated raw gypsum. These fragments, contained in plaster as well as those found in "overburnt" gypsum up to a burning temperature of 800 centigrade, have the shape of splinters and spikes or resemble small rods and pins, if the raw gypsum had a fibrous structure. On the other hand, genuine hydraulic gypsum shows, even if magnified only 300 or 500 times, a peculiar granular structure. After washing out of the fine particles, the coarse feels as hard as sand grains and is difficult to grind. These sintered particles possess polygonal shape and have sharp or rounded corners; they are double-refracting. The laminated structure of the crystal fragments of raw gypsum, however, which becomes visible only upon driving off of the water of crystallization at low temperatures, and which, therefore, characterizes plaster of Paris and slow-setting plaster, is not to be found in the case of hydraulic gypsum. Cut No. 9, shows the coarser particles of genuine hydraulic gypsum, commercial product; cut No. 10, is the same preparation as No. 9, but in this case the coarse particles have been broken up by grinding them between cover glass and slide. Cut No. 11, represents powdered plaster of Paris, commercial product, for comparison. This last cut is likewise an illustration for slow-setting plaster, "overburnt" gypsum.



No. 9. Powdered hydraulic gypsum (commercial product) after washing out of the finest particles. The coarse consists of a multitude of grains fused together. They can be separated by pressure on the cover glass and then present the view given by cut No. 10. Magnified 200 times.

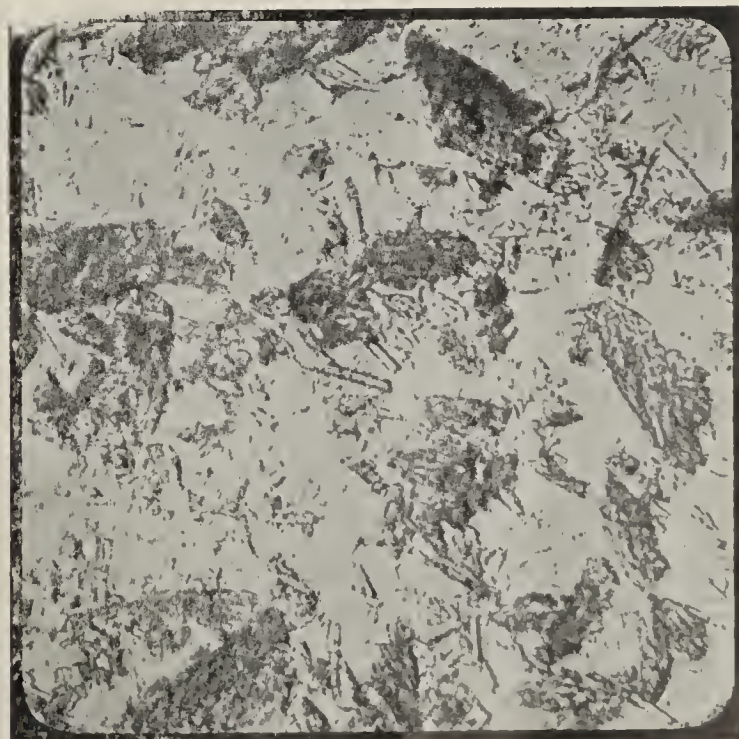
The shape and optic properties of hydraulic gypsum are so characteristic, that it is impossible to mistake it for plaster of Paris. Even a small admixture of one kind to the other can easily be detected by the microscope. A further method of distinguishing them furnishes the examination under crossed Nichols, whereby hydraulic gypsum shows brilliant colors. The grains and other elements of which the hydraulic gypsum may be composed are crystalline, double-refracting and apparently belong to the rhombic system. If placed in water, they do not change their form, not even after several months, and are not inclined to re-crystallize as di-hydrate.



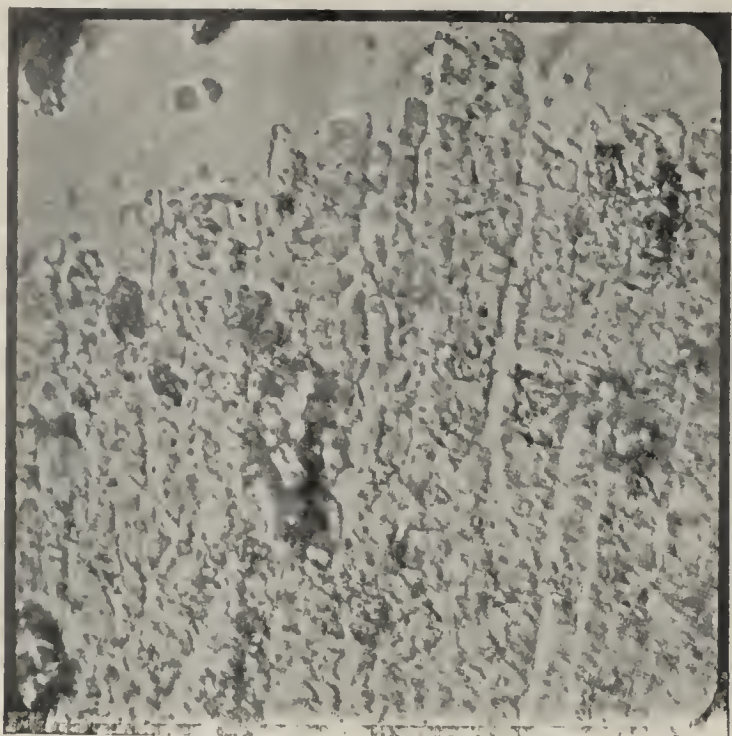
No. 10. Grains composing hydraulic gypsum. Same preparation as No. 9. Magnified 360 times.

What Temperature is Required for Burning Hydraulic Gypsum? In looking for an answer to this important question in the available literature, one finds nothing but uncertainties and conjectures. While the temperature interval of 525 to 600 centigrade was formerly declared to be the proper burning temperature, modern investigators place it as low as 400 and even between 200 and 400 centigrade. But that in all the numerous observations on record "overburnt" gypsum, slow-setting plaster, was used instead of hydraulic gypsum is evident from the description of the properties of the materials under examination and from the accompanying micro-photographs. All these various grades of gypsum had nothing in common with the commercial genuine hydraulic gypsum which, as every manufacturer of this product knows, can only be obtained at a bright red heat corresponding with a temperature of from 900 to 1000 centigrade.

In order to ascertain the limits of temperature between which the granular modification of the anhydrite is formed, which microscopic investigation proved to be hydraulic gypsum, small samples of various kinds of raw gypsum were burnt in a furnace,



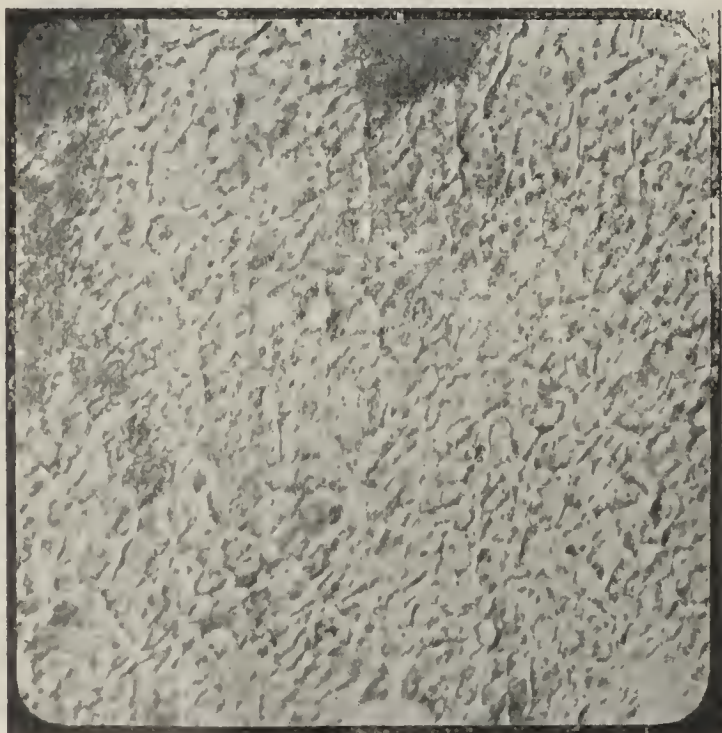
No. 11. Powdered plaster of Paris (commercial product). All kinds of gypsum obtainable by burning between 107 and 800 centigrade show these same elements. Magnified 360 times.



No. 12. Hydraulic gypsum burnt at 900 centigrade. Section through an unbroken piece showing parallel stripes originating from the fibers of the raw gypsum. The dark spots are adulterations of clay. Magnified 750 times.

heated by electricity, at temperatures of 600 centigrade, 700, 800 and so on, the temperature of each following burning being 100 centigrade higher. The heat was measured by a Le Chatelier pyrometer. The burning time was from 3 to 4 hours which was sufficient for pieces of gypsum of nut size. Microscopic examination of the products obtained had the following result:

The structure of the samples burnt at 600 and 700 centigrade could not be distinguished from that of plaster of Paris. These temperatures, therefore, yield exclusively "overburnt" gypsum. The product burnt at 800 centigrade, however, if slightly magnified, showed still the same laminated structure characteristic of dehydrated gypsum for all temperatures up to 700 centigrade and as shown by cut No. 5. Upon more powerful magnification, the laminae could be discerned to consist of minute grains, of the shape of those to be found in hydraulic gypsum, especially at the thin edge of the specimen under observation.



No. 13. Hydraulic gypsum burnt at 900 centigrade. Section through an unbroken piece showing the granular elements composing it in their original place. Magnified 750 times.

Mixed with water, this sample hardened well and acted like hydraulic gypsum. The granular modification of anhydrite, however, attains its full development only at a temperature of 900 centigrade, when microscopic sections present the structure given by cuts No. 12 and No. 13.

Cut No. 12 shows the less frequent occurrence of grains arranged in parallel lines by breaking up, on account of sintering, of the fibers composing the raw gypsum; cut No. 13 shows the grains in irregular position and distinctly separated one from another. The samples burnt at 1000 and 1100 centigrade differ from those obtained at 900 centigrade only by the larger dimensions of the grains.

Chemical Composition of Hydraulic Gypsum: The erroneous assumption that hydraulic gypsum was formed at temperatures between 400 and 600 centigrade, within which interval no chemical change in the composition of the gypsum could be discovered to take place, outside of giving off its water of crystallization, induced chemists to declare, that hydraulic gypsum was "a second anhydrous modification of gypsum" and that it had the same composition as the slow-setting I. anhydrite obtainable between 200 and 300 centigrade. Yet, in making this statement it was overlooked that the hydraulic gypsum, as supplied by the manufacturer, invariably contains more calcium oxide than corresponds with the amount of sulphuric acid present. This surplus of calcium oxide may originate from two causes: It may derive from the decomposition of calcium carbonate, if the native gypsum employed in the manufacture contains some of this, or it may be due to a partial evaporation of the sulphuric acid of the gypsum. Now, a similar partial decomposition of gypsum takes place, according to my experiments, at a temperature of 800 centigrade, that is to say at the minimum temperature necessary for the formation of the granular modification of the anhydrite, and must be considered inseparable from the burning of hydraulic gypsum. The surplus of calcium oxide grows with the increase of the burning temperature as the following table illustrates:

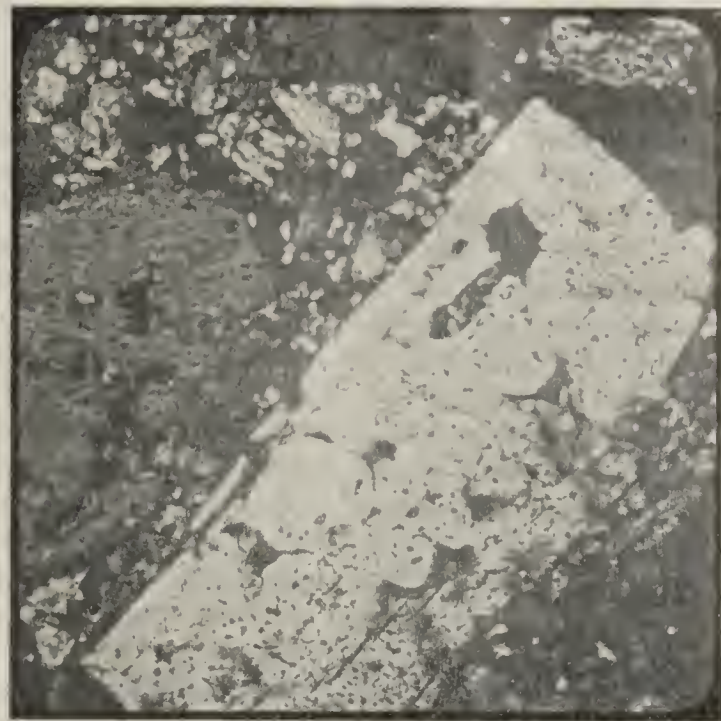
Chemical Composition of Burnt Product in Per Cent:					
Temperature In Centigrade	Calcium Oxide	Sulphuric Acid	equal to	CaSO ₄	+ CaO
800	42.64	57.02		96.93	2.73
1100	43.06	56.40		95.88	3.58
1400	47.72	51.88		88.20	11.40

This "free" calcium oxide, originating from a partial decomposition of gypsum, behaves, during the hardening of hydraulic gypsum, in an entirely different way from free calcium oxide derived from calcium carbonate, as my experiments prove. Also micro-photographs show a marked difference. A mixture of 2 parts of gypsum and 1 part of finely pulverized chalk, burnt at a temperature of 1070 centigrade, presented under the microscope the minute grains of calcium oxide between the much larger grains of hydraulic gypsum, which latter also enclosed grains of calcium oxide. No action whatever of one constituent upon the other was revealed by any change of form which might possibly have taken place. In accordance with this observation, the pulverized calcined product developed considerable heat upon being mixed with water and resulted, after having hardened, in a chalk-like mass of low strength, that, by the way, did not show signs of blowing, because the calcium oxide hydrated immediately upon mixing of the powder with water.

On the other hand, the calcined products of pure raw gypsum did not show any signs whatever of free calcium oxide, not even the sample burnt at 1400 centigrade, and all of them showed normal hardening. The hydraulic gypsum burnt at 1400 centigrade developed even a remarkably high strength. Also a sample, placed in a furnace in which china was burnt at 1370 centigrade and which, on account of too long exposure to the fire, contained only 17% of calcium sulphate and 83% of "free" calcium oxide, hardened well and exhibited no signs of blowing.

The next question occurring to one's mind is: **In What Form is the Calcium Oxide Contained in Hydraulic Gypsum?** To this a satisfactory and at the same time surprising answer was obtained from a study of the microscopic sections of the samples burnt at higher temperatures, for instance at 1300 centigrade. As a result it must be stated that hydraulic gypsum is by no means a homogeneous body, as was the general belief so far; it consists of two components, in the first place of the above mentioned grains or polygons and in the second place of a glassy substance surrounding the former. The granular constituent is, as formerly described, undoubtedly crystalline and double-refracting, the latter substance, in distinction thereof, amorphous and from an optical standpoint inactive. On microscopic sections (see cut No. 14) the glass substance appears as network enclosing in its meshes the grains or polygonal bodies.

There is no doubt that the "free" calcium oxide of hydraulic gypsum is contained in the glassy substance, while the grains represent a special granular modification of the anhydrite of calcium sulphate. This follows from the quantitative proportions of the "free" calcium oxide to calcium sulphate in the burnt products and from those of the glass substance to the granular part in the corresponding micro-photographs. The commercial hydraulic gypsum, which is burnt at a temperature between 900 and 1000 centigrade, contains on an average 3% of "free" calcium



NO. 15. Microscopic section of hydraulic gypsum burnt at 1400 centigrade, showing characteristic plates of sintered anhydrite. The dark parts represent glassy "basic calcium sulphate." Magnified 100 times.

oxide, unless the raw gypsum contained calcium carbonate. The glass substance, therefore, becomes hardly visible and can be distinguished as network only upon powerful magnification. My attention was called to it for the first time by sections secured from samples burnt at higher temperatures which contained larger amounts of "free" calcium oxide. In these the glass substance became plainly noticeable even if magnified moderately.

The "free" calcium oxide is evidently an important part of hydraulic gypsum; it belongs to its chemical constitution and must not be regarded as adulteration or occasional admixture as done heretofore. However, it is not contained in it in a free, uncombined state in the usual sense of the word, as it can not be detected by the microscope. The glassy substance, therefore, (which has merely been termed thus on account of its transparency and not because it was supposed to resemble glass from a chemical standpoint) must either be a basic calcium sulphate or must represent a solution of calcium oxide in neutral calcium sulphate.

Theory of the Formation of Hydraulic Gypsum: The results obtained from the foregoing observations explain the chemical processes going on during the burning of hydraulic gypsum. With increasing temperature the raw gypsum passes through the stages of the half-hydrate, of the quick-setting and slow-setting I. anhydrite and as continuation of the latter that of the overburnt gypsum. The point, when the calcium sulphate begins to decompose, under partial evaporation of the sulphuric acid, is at the same time the beginning of the glassy formation of "basic calcium sulphate" and of the granular modification of anhydrite. This takes place at a temperature of about 800 centigrade. The grains are still exceedingly small at this temperature. Upon increasing the temperature to 900 centigrade and upon further evaporation of small amounts of sulphuric acid, which means also further formation of the glassy component, the grains obtain the normal size of the commercial hydraulic gypsum. If the burning temperature is further increased, the glassy "basic calcium sulphate" assumes even larger proportions and the grains of anhydrite become still larger



NO. 14. Hydraulic gypsum burnt from alabaster gypsum at 1300 centigrade. The grains of anhydrite lie in a network of a fused glassy "basic calcium sulphate." In comparing the photograph of this preparation with Nos. 12 and 13 it must be remembered that it has been enlarged only half as much as the latter. The grains are much larger in this sample of hydraulic gypsum on account of the higher burning temperature. Magnified 375 times.

until, at about 1400 centigrade, near the fusing point of the mass, a coarse crystalline product is obtained composed of large amounts of plates and tablets of anhydrite in addition to the customary round or polygonal grains. These plates obtain a length and width of 1 millimeter and more and are divided in smaller areas by shrinking cracks crossing at right angles. Cut No. 15 shows a similar plate; the glassy "basic calcium sulphate" partly fills out the cracks, partly it covers the plate at a number of places. Where it predominates, it often encloses grains of anhydrite on the point of decomposition.

The genuine commercial product of hydraulic gypsum contains all sizes and forms of anhydrite, from the minute grain formed at 800 centigrade up to the large plates corresponding with temperatures of 1300 and 1400 centigrade. The most frequent, however, are the round or polygonal grains of medium size which are principally formed between 900 and 1000 centigrade. This shows that the temperature differs widely in the same furnace, which can not be avoided, of course, if the charge of the kiln consists of alternate layers of raw gypsum and coal. Fortunately the quality of the calcined product is not impaired by it, as all grades of hydraulic gypsum burnt between 800 and 1400 centigrade harden well. A matter of great importance, however, is that the burning is done with an oxidizing flame. A reducing atmosphere causes formation of calcium sulphide and decreases the value of the burnt product.

(To be Continued.)

THE NATIONAL ASSOCIATION OF CEMENT USERS.

The sixth annual convention of the National Association of Cement Users was held in Chicago, Feb. 21-25. The convention was the largest in the history of the organization, about 350 members registering, and the papers presented were, in the opinion of the members generally, of greater value than those of any former convention. Reinforced concrete work was given its customary prominence in the proceedings. Aside from a number of spirited discussions regarding details of concrete pavements, sidewalks and building block construction, the greatest interest was shown in the papers relating to concrete houses and different methods of finishing and decorating concrete surfaces. The committee having the latter matter in hand presented an elaborate report, which in its final form will occupy 50 or more pages in the association's "Proceedings."

By far the most important work of the convention was the consideration of the proposed standard specifications for Portland cement street pavements, curb and gutter, drain tile and architectural concrete blocks; of the proposed standard building regulations for the use of reinforced concrete and of the amendments offered to the present standard specifications for cement sidewalks. Their disposition is noted below under the appropriate heading.

General.

The report of the treasurer showed a balance on hand on Dec. 31, 1909, of \$1,136.52. The membership at the close of the 1909 convention was 833. Since then 260 delinquent members have been dropped and 204 were gained up to the opening of this convention, giving a total on Feb. 20 of this year of 777. During

the convention sufficient new members were obtained to outstrip the membership at the close of the previous convention. In view of the fact that this membership is full paid and active, the executive board expressed itself as well pleased with the showing.

The efforts to secure a large contributing membership were attended with but little success, and it was urged that an attempt be made to raise the funds required to carry on the work of the association by an aggressive campaign to increase the active membership. In order to decide upon a line of action a meeting was held of those who expressed a willingness to help in such a campaign.

A number of important changes were made in the by-laws of the association. The chief one provides for the appointment of the chairmen of the special committees, replacing the former scheme of electing them in the convention. The executive board in future will consist of the president, the vice-presidents and the five latest living past presidents. Of these, only five, the president and the first, second, third and fourth vice-presidents, will be elected. The elected members of the board will appoint the secretary and the treasurer, create all special committees and appoint a chairman of each committee who shall be a vice-president of the association. Four additional members of each committee shall be appointed by the president in consultation with the chairman of the committee.

In order that the expenses of the association may be properly analyzed, the beginning of the fiscal year was transferred from Jan. 1 to July 1. As it was formerly, the convention expenses were distributed to two fiscal years.

The following officers were elected: President, Richard L. Humphrey, of Philadelphia; first vice-president, E. D. Boyer, New York; second vice-president, M. S. Daniels, New York; third vice-president, E. S. Larned, Boston; fourth vice-president, F. A. Norris, Boston. The first and fourth vice-presidents are the only new officers, replacing Mr. Merrill Watson, of Newark, who is in Europe, and Mr. G. C. Walters, of Atlanta, who asked to be relieved. A resolution was passed thanking these two gentlemen for their services to the association.

At the close of the convention special committees were announced and the chairmen of them appointed. The committees and their chairmen are as follows: Insurance, Mr. W. H. Ham, Boston; Reinforced Concrete and Building Laws, A. E. Lindau, St. Louis; Exterior Treatment of Concrete Surfaces, L. C. Wason; Exhibition, H. S. Doyle, Chicago; Roadways, Sidewalks and Floors, C. W. Boynton, Chicago; Building Blocks and Cement Products, W. P. Anderson, Cincinnati; Fireproofing, Mr. R. P. Miller, New York. Mr. H. C. Turner was reappointed treasurer. No secretary was appointed, since the executive board wishes to take this matter under advisement.

Invitations for the next convention were received from Rochester, Cincinnati, Chattanooga, St. Louis and Atlantic City. The matter was referred to the executive board with power to act.

At the close of the convention resolutions were adopted urging State universities to install courses in the design and construction of concrete work, and urging Congress to appropriate sufficient funds for the Technologic Branch of the United States Geological Survey, so that it may continue its investigations of building materials.

Reinforced Concrete.

The report of the committee on reinforced concrete was not put in final shape for presentation to the con-

vention and is not now available for publication. It was offered as a progress report and before its appearance in the "Proceedings" of the association will be revised in detail. It covers the factors involved in the design of plain and reinforced concrete structures, pointing out the accepted theories and the points on which data are insufficient for the establishment of absolutely rigid specifications and methods of design.

Mr. H. C. Turner urged that the committee outline tests of full-sized bays, because the assumed bending moment varies greatly with different designers and only adequate experiments can secure sufficiently definite results to harmonize practice. Mr. Humphrey endorsed Mr. Turner's suggestions, saying that the association had now reached a point where instead of merely summarizing opinions and drawing conclusions from the work of others, it should push out and by investigation become a pioneer in the developing of proper designing methods.

Mr. A. E. Lindau, in answer to criticism of the large amount of room required by concrete columns in the lower stories of high buildings, stated that a recent investigation had shown that steel columns fireproofed took up practically the same percentage of floor area as reinforced concrete columns.

The papers on reinforced concrete covered both floor and column design. Mr. Sanford E. Thompson presented one on "Longitudinal Reinforcement in Concrete Columns," in which he quoted tests to show that the opinion that vertical bars do not add to the strength of columns is unfounded and that such opinion is contrary to both test results and practical considerations. Mr. Charles D. Watson, of Syracuse, presented a paper on the use of "Separately Molded Members," in which he reviewed the chief structures of that character erected in the United States, and the various patented systems on the American and European markets. The structures in this country particularly referred to were the Textile Machine Works, Reading, Pa., several buildings for the Onondaga Litholite Company, Syracuse, N. Y., a building of the Edison Portland Cement Company, at New Village, N. J., and the barn of the Central Pennsylvania Traction Company, at Harrisburg, Pa. The buildings for the Onondaga Litholite Company were designed by Mr. Watson. The cost of separately molded floor members, he stated, is much greater than the cost of making and placing concrete blocks. He believes a large reduction can be expected as the methods of manufacturing separately molded members are perfected, but even at the present price they compare quite favorably with the cost of monolithic floors for the same spans and loads.

A paper was read on "Reinforced Concrete Columns," by Mr. Peter Gillespie, and one on "Long Span. Light Floor Reinforced Concrete Construction," by Mr. E. G. Perrot.

A paper on flat slab floor construction was presented by Mr. Angus B. MacMillan. A paper on "The Comparative Cost and Efficiency of Reinforced Concrete Gravity Dams" was to have been presented by Mr. W. L. Church and H. L. Coburn, but neither of these gentlemen was able to attend. Mr. Robert A. Cummings read a paper on "Lateral Reinforcement of Compression Members."

Building Laws, Insurance and Fireproofing.

The committee on building laws presented a progress report in which it submitted to the convention a revision of the proposed standard building regulations. As now submitted the regulations are quite similar to those discussed very fully and voted on at the last convention. The proposed standard regula-

tions were accompanied by a tabulation from the building code requirements of the principal cities of the country so as to afford a comparison with the proposed regulations. Moreover, in order to invite discussion of the question of hooped columns the committee appended excerpts of the building laws of Chicago, St. Louis and Cincinnati and a discussion of the subject by Mr. E. G. Perrot.

The regulations as proposed contained a clause regarding high carbon steel, which specified that new billets should be used, that the ultimate strength be 88,000 lb. per square inch with an allowable range of 8,000 lb. and that the elongation in per cent. in 8 in. be $1,200,000 = (\text{ultimate strength})$. After long discussion this was changed so that it now specifies that "high elastic limit steel" shall have an elastic limit of 50,000 to 65,000 lb. per square inch, and a minimum elongation in per cent. in 8 in. of $1,000,000 = (\text{ultimate strength})$. The remainder of the paragraph, specifying a cold bend test of 180 deg. around four diameters without fracture, was left unchanged.

The clause specifying that wire up to $\frac{1}{4}$ in. should be manufactured from Bessemer or basic open-hearth steel, but not from rerolled rails, was stricken out, since other clauses covered the case satisfactorily. The matter of rerolled rails caused a great deal of discussion. The prevailing opinion seemed to be that reinforcing bars made of this material are not uniform, and should not be used. On the other hand, some of the members believed that the source of the metal is immaterial, so long as it complies with the specifications.

The question was raised in the discussion whether it was advisable at the present time to draw a specification regarding fireproofing, and while the committee stated that data are too meagre to speak with authority it was considered best to leave the present clause stand until the committee on fireproofing can propose a more detailed one. The clause now provides for a minimum of 2 in. of fireproofing outside the main reinforcement of columns, $1\frac{1}{2}$ on beams and girders and 1 in. on floor slabs.

The committee was continued and in accordance with its recommendations the regulations will be referred to a letter ballot of the members.

The report on insurance stated that the committee has on file a list of about 1,000 concrete buildings and that the committee has written to the owners for information regarding their insurance. Replies, 225 of them complete, have been received from about 300 buildings. On 26.6 per cent of the buildings no insurance is carried, and some owners do not insure the contents of such buildings. The data have been tabulated by dividing the United States into six districts and classifying the buildings in each according to their uses. The average rate for all classes of buildings is 41.6 cents per \$100. The committee considers all rates above 50 cents per \$100 abnormally high. It has, therefore, given also an average rate excluding all such high rates. This average is 22 cents per \$100 for all classes of buildings.

The report of the committee on fireproofing stated that the proper amount of fireproofing material required to protect the structural members of a building against the destructive effects of fire is now only a matter of opinion. The data from fire tests and actual fires are too meagre to draw conclusions and, therefore, the committee deemed it best to study the question and gather information before attempting to draw up specifications. The committee also believed it its duty to study other materials used for fireproofing as well as concrete. In order to gather

data the committee has formulated a schedule of the information desired.

Among the considerations which the committee thinks should enter into any study of the behavior of fireproofing the following may be mentioned: Should the proper protection be capable of safely resisting only the ordinary conditions of a fire, or should it provide for the extraordinary conditions as well? What may be accepted as the ordinary conditions of a fire, what temperatures and for what length of time? Can fireproofing be properly graded to suit various degrees of hazard? What effect, if any, does the composition of the materials have on the efficiency of the proposition; is, for instance, any one mixture or proportion of concrete inferior to another, or is one kind of clay for terra cotta better suited than another? The thickness and method of application of the protective material must, of course, play very important parts in this investigation.

The report of the committee was accepted and the committee continued.

Exterior Treatment of Concrete Surfaces.

The report of the committee on exterior treatment of concrete surfaces was unusually complete, and was the subject of very favorable comment on the part of the members of the association. It is not now available for publication, but will appear in full in the "Proceedings." It was offered as a progress report, since the committee is not ready now to recommend methods of surface treatment.

The main subdivisions of the report are: (1) The removal of the surface to expose the aggregate; (2) methods of removing this surface, as by washing, tooling and sand blast, and the advantages or disadvantages of each; (3) coating the surface, and methods and materials for such work; (4) ornamental work cast in molds; (5) waterproofing; (6) surface defects and troubles with different surface finishing methods; (7) specifications; (8) cost.

Mr. L. C. Wason, chairman of the committee, took up a few points of the report in detail. Information was desired, he stated, on the effect of tooling on the impermeability of the concrete. The general opinion is that since the surface concrete or mortar is the denser, a removal of this lessens the impermeability of the concrete. Quantitative data are wanted on this subject.

The amount of crazing increases as the amount of cement in the mortar increases. All cement surfaces craze, and the more dense the surface, the greater the crazing. Waterproofing the surface with hydrated lime or clay does not stop crazing, but since dirt does not lodge in the cracks so easily they do not show so quickly. Even surfaces which have been scrubbed to expose the aggregate are subject to crazing, but the lines run around the exposed large particles and thus are not so easily noticed.

In connection with exterior treatment of concrete surfaces may be mentioned two well-received papers on small concrete residences, one by Mr. Milton D. Morrill, of Washington, and one by Mr. C. R. Knapp, of Philadelphia. Both were illustrated by views of concrete houses, showing plans, details of finish and decorative work, and completed buildings.

The annual address of the president related largely to exterior finishing. It was an informal talk about Mr. Humphrey's recent trip to Europe and was illustrated by a large number of views of European con-

crete structures. He thought the European concrete works were ahead of those in the United States in architectural finish and grace of design. The tendency toward more graceful designs, however, is evident in the United States, and while European countries excel in this detail, Mr. Humphrey thought that we are, on the whole, farther ahead than they in the use of concrete. The greatest field here lies in the development of its artistic treatment. Before publication in the "Proceedings" Mr. Humphrey's address is to be considerably elaborated, and will be accompanied by views.

Sidewalks and Roadways.

The committee on roadways, sidewalks and floors presented two new proposed standard specifications, for concrete roadways and for curbs and gutters, and also revisions of some clauses in the existing standard specifications for Portland cement sidewalks. There are many matters relating to mixing and placing concrete which are applicable to all of these specifications and such matters have been made uniform in all three.

The chief revision of the present standard specifications for cement sidewalks consists in the addition of specifications providing for a subbase where required. The convention also accepted, with amendments, the proposed standard specifications for concrete roadways and street pavements, and these, likewise, will now go to the members for adoption by letter ballot. Concrete pavements were the subject of a spirited discussion at the experience meeting preceding the presentation of the committee's report. In regard to the method of finishing the surface the sense of the meeting seemed to be that the best way is to float it with a wood float. Grooving was discussed, and, in fact, was proposed in the committee's draft of the specifications. The experience of the members indicated that while grooving afforded a better foothold for the horses it was the principal source of wear in the pavement, since the grooves spall rapidly. This fact induced the convention to strike the optional clause regarding it from the proposed specifications.

A paper on concrete roadways was presented by Mr. Frank R. Charles, city engineer, of Richmond, Ind., in which he described a pavement laid in that city in 1896. Not a cent has been spent on this road for repairs. Other roads have been similarly paved since then and have proved satisfactory.

Only a few minor changes were made in the proposed standard specifications for Portland cement curb and gutter offered by the committee. These specifications will now go to the members by letter ballot.

Concrete Blocks and Drain Tile.

Concrete blocks and tile received a great deal of attention during the convention. The committee on specifications for cement products offered a draft of specifications on architectural concrete blocks with the recommendation that it be discussed, but not adopted. A great deal of valuable information was offered during the discussion and the committee announced that it would embody the best of the recommended clauses in a new draft to be submitted to the next convention. Among the suggestions were that the committee consider the advisability of inserting in the specifications clauses regarding absorption and crushing strength.

The specifications on drain tile were discussed in

the convention and by a joint committee made up of members of the National Association of Cement Users and of members of the Interstate Tile Association, which was holding a convention in Chicago at the same time. As a result of the discussion in the convention and of this conference the committee deemed it advisable to have the specifications referred back to it, in order that a revised draft might be submitted to the next convention.

In connection with concrete blocks there were discussions of steam curing and of curing plants. A paper on the subject was presented by Mr. F. S. Phipp. A paper on hollow block manufacture was presented by Mr. E. B. McCready and one on concrete drain tile by Mr. J. H. Libberton.

Miscellaneous.

Among the miscellaneous papers was one by Mr. Olaf Hoff, describing the laying of concrete under water in the Detroit River Tunnel. Another by Mr. R. S. Greenman described the concrete work on the Barge Canal. Mr. Joseph A. Holmes, of the Technologic Branch of the United States Geological Survey, was kept away by illness. Other papers were presented as follows: "The Preparation of Concrete," by H. F. Porter; "Concrete for Maritime Structures," by Chandler Davis; "Concrete for Farm Buildings," by S. Cunningham, Jr. A number of other papers were presented.

As Mr. Hoff explained, the chief difficulty among the many presenting themselves seems to be the conveying of the mass of semi-fluid concrete mixture through the water to its place of deposit in such a manner as to preserve the mixture intact and prevent aggregation of its integral parts, which would leave only an inert mass of aggregate. Mr. Hoff went on to say that as far as he has been able to learn, the most satisfactory method of any tried to date has been the use of tremies. Mr. Hoff very aptly illustrated his point by describing the construction of the Detroit River Tunnel, which was completed by this method. The paper was well given and was heartily received by the audience.

MR. P. B. BEERY RESIGNS.

Mr. P. B. Beery has severed his connection with the Sandusky Portland Cement Co., after nearly 14 years of service, to become secretary and treasurer of the Allentown Portland Cement Co., of Allentown, Pa., in which place he will have direct charge of sales. The Allentown mill has an initial daily capacity of 3,000 bbl. and has been designed for future extensive enlargement. It was planned by the president of the company, Mr. Charles A. Matcham, formerly general manager of the Lehigh Portland Cement Co.

CEMENT DEPOSITS IN WISCONSIN.

Fond du Lac may become the center of a great cement industry. Capitalists are just now considering the question of establishing a plant according to reports, and should it prove that good cement can be manufactured, others will enter the industry, as the supply in this part of the state would be inexhaustible.

That the great ledges around here are practically full of the commodity has just been announced by Proff. S. F. Gilman of Ripon college, and if he is correct in his analysis, millions of dollars' worth of material will be manufactured here in the near future.

NEW ATLANTA OFFICE.

The Power & Mining Machinery Company of Cudahy, Wis., have just opened a district office in the Equitable building, Atlanta, Ga., in charge of Mr. Lloyd St. John Smith. The company manufactures mining, crushing and cement making machinery.

NORTHWESTERN CEMENT PRODUCTS ASSOCIATION.

The Northwestern Cement Products Association held its opening meeting in parlor L 38 of the Great Northern Hotel, Chicago, Friday, Feb. 18, at 2 o'clock. In spite of the snow storm of a few days ago, there was as large an attendance as had been anticipated. Every member present was enthusiastic on the subject of cement and with the anticipation of attending the big cement show.

On account of the illness of Martin T. Roche, president of the association, Mr. Kingsley presided at the meeting, and W. C. Berry, Minneapolis, was appointed temporary secretary.

E. M. Hagar, president of the Cement Products Exhibition Company, delivered the address of welcome and urged the association to work for the advancement of the cement industry, which has a brighter future today than any other field of commercial activity.

O. U. Miracle, of the Miracle Pressed Stone Company, Minneapolis, read an interesting address on "Cement Sewer Pipe," and A. W. Menk, of the Consolidated Elevator Company, talked on "Concrete Country Grain Elevators." Both of these papers were discussed at some length by the members.

Saturday's Session, February 19.

The second session of the Northwestern Cement Products Association was held and some of the business of the organization transacted. There was a good crowd of delegates present and the enthusiasm manifested at the first meeting was still maintained.

A. H. Laughlin, Lisbon, N. D., who was snow-bound and missed the official train from Minneapolis, was on hand at Saturday's session and assumed his duties as vice-president.

J. V. Godfrey, Moorhead, Minn., read a most interesting address on "A Concrete Cattle Barn," which was discussed freely. There was also quite a little discussion on the subject of what was necessary in making a good concrete. The point was brought out that good pure water was essential in getting good results. Some members said they were unable to get satisfactory results when river water was used, and that the trouble seemed to be that in certain localities river water as well as certain spring or well waters contained too much alkali. The importance of pure water, free from traces of alkali in any appreciable quantities, was admitted by all.

Saturday afternoon was given over to a visit to the Universal Portland Cement Co.'s mill at Buffington, Ind. Many members of the association had expressed a desire to see a cement mill and go over the process in detail of making cement. Accordingly the Universal boys arranged for a trip and the excursion train pulled out at 2 o'clock and back at 6 p. m., in time so that it would not interfere with the evening engagements of those who made the trip. When they all returned they were wiser, but admitted that a ce-

ment mill is about as dusty a place as a country road in the summer time after six weeks without rain.

Monday's Session, February 21.

The last session of the sixth annual convention of the Northwestern Cement Products Association opened Monday morning in the Great Northern Hotel. The following addresses were made: "Cement Products in the Northwest," by A. H. Laughlin, Lisbon, N. D.; "Surface Finish for Concrete Work," J. H. Chubb, and "Sheet Steel Piling," by J. R. Hoppin.

Richard L. Humphrey, president of the National Cement Users' Association, addressed the convention and spoke on the work to be done by associations such as the Northwestern Cement Products Association. He also urged the delegates to remain the rest of the week and spend their time attending the convention of the National Cement Users' Association.

A telegram was sent to Martin T. Roche, president, who has been sick for weeks, expressing the sympathy of the association, with the sincere hope for his speedy recovery.

The nominating committee, composed of O. U. Miracle, chairman; R. K. Hofoss and W. S. Kingsley, submitted the following report, which was adopted:

"Your committee on nomination beg leave to report as follows:

"Inasmuch as articles of incorporation have been adopted providing for the election of officers on the first Monday in October of each year, we recommend that A. H. Laughlin, of Lisbon, N. D., be elected president to serve with the other present vice-presidents until October, 1910, and that the secretary be instructed to cast the unanimous ballot of the association for the following officers for the ensuing year, on the first Monday in October, 1910:

H. E. Murphy, of Manitowoc, Wis., president; Martin T. Roche, St. Paul, Minn., first vice-president; A. H. Laughlin, Lisbon, N. D., second vice-president; R. K. Hofoss, Aberdeen, S. D., third vice-president; C. K. Anderson, Owatonna, Minn., fourth vice-president; Jos. V. Godfrey, Moorhead, Minn., fifth vice-president; J. N. Hazen, treasurer; H. B. Smith, Minneapolis, secretary.

INTERSTATE TILE MEN MEET.

The annual convention of the Interstate Cement Tile Manufacturers' Association held its first meeting at the Lexington Hotel, Chicago, Tuesday morning, February 22.

The meeting was called to order by President L. L. Bingham, of Estherville, Ia. Owing to the sickness of Secretary Chas. E. Sims of Worthington, Minn., he was unable to be present and Vice-President D. G. Keith of Ceylon, Minn., acted in his stead.

The cement tile industry is one of the growing branches of the concrete industry, and in the past few years it has developed more largely probably than any other branch. The association organized a few years ago, has made rapid progress and it is doing some very effective work under the leadership of its able officers.

The president introduced Norman D. Fraser, vice-president of the Cement Products Exhibition Company, who gave a very hearty welcome to the visitors. He said he hoped that their meeting would be profitable to them and as this was the first time they had

met in Chicago, that the attendance would be large. He extended a very hearty welcome on behalf of the city and the Cement Products Exhibition Company. The response on behalf of the tile manufacturers was made by Dr. Baldwin of Coldwater, Mich., who thanked Mr. Fraser for his welcome.

Informal discussions were entered into and President Bingham called on the representatives of power machines to discuss the merits of their machines in connection with manufacturing tile.

February 22, Afternoon Session.

President Bingham called the meeting to order in the convention room of the Lexington Hotel. He called upon George Deickmann, chief chemist of the Northwestern States Portland Cement Co., for a discussion on steam curing cement tile.

Mr. Deickmann said that he had been making a number of tests on steam curing cement products, the results of which are published in a pamphlet issued by his company. He said he did not believe that it was necessary to sprinkle concrete tile after it had been steamed. They intend to continue their experiments on tests for the next year, using different mixtures and treating them in different ways. He warned tile men about having steam too hot. It should be introduced into the curing room moist. The curing room should be kept at a temperature of 80 to 90 degrees cent. and the steam should be kept at about the same temperature. The most important chemical action in tile takes place during the first twelve hours. In the first forty-eight hours, 50 per cent. of the tensile strength of the tile is developed. In seven days about 75 per cent. has been developed. In twenty-eight days 85 per cent. has been developed, and to attain the maximum strength of the cement it takes from one to two years. He advised that the steam should not be applied to the tile until the initial set had taken place or at about the end of seven hours after the tile had been made. A good way to test the tile would be to see if an impression could be made by a finger mark.

Dr. Baldwin gave some very interesting information on the subject of steam curing. He said that he had a curing room 11 feet by 100 feet in length. Two-thirds the length of this kiln he had a tank 4 feet by 8 feet and 2 feet deep. In this he kept cold water. Steam pipes from the boilers are connected with this tank and the steam therefore had to pass through the water in order to circulate through the curing room. He said excellent results had been secured by this method.

Considerable discussion was created on this subject after which Mr. Deickmann read a paper on the subject of "The use of Cement in Water."

After the reading of this paper, the president named the following nominating committee: Messrs. Sokol, Girth and Baldwin.

President Bingham then called upon E. A. Shaver for a talk on "Plant Location and Equipment." Mr. Shaver said that he had operated a plant at Wellman, Ia., to which he was obliged to ship his sand and make a haul of over a mile to the plant. Besides this, he was obliged to compete with a clay tile plant, which was against him. He moved last year to Columbus Junction, Ia., and is now located near his supply of sand as well as having four railroads for shipping facilities. He forcibly impressed on the manufacturers the necessity of being near the raw material supply.

P. H. Atwood then gave a strong talk on "The Ne-

cessity of Adopting the Standard Specifications for Cement Tile," and supplemented these remarks by a paper on this subject. As he is chairman of the committee in charge of the specifications, he urged the members to carefully consider the suggestions offered by the committee before Wednesday morning.

Following this, a discussion was entered into by various members on "The Use of Sand in the Aggregate—To What Proportion the Fine and Coarse Should Be Mixed, Etc." Dr. Baldwin presented a very strong talk in regard to proportion. He said that no set rule can apply to proportioning the aggregate. No two sand pits are alike. The best way to find the proportion is to fill a box with sand and measure the water to find out the amount of voids in the sand, then to allow the same amount of cement to be applied in this aggregate in order to fill the voids.

The executive session of the Interstate Cement Tile Manufacturers' Association was called to order by President Bingham in the convention hall of the Lexington Hotel for the morning session of February 23. A large number of other manufacturers had arrived in the city for this session and much enthusiasm was displayed. The session was for the members only and it was one of the best that has ever been held by the association.

The principal topic under discussion was "Manufacturer's Cost, Data, Profits, and Labor Saving Devices." One report presented was by far the most interesting paper that has ever been presented on this subject. It was by J. H. Libberton, assistant inspector engineer Universal Portland Cement Co. of Chicago. Mr. Libberton has spent several months visiting the various cement tile plants and collaborating the data which was contained in his report. It consisted of the cost of manufacturing cement tile and labor saving devices in plants as well as the manufacturing of machinery for handling the products. He illustrated his talk with stereopticon views of the many plants he has visited as well as pictures of work in which cement tile has been used.

His paper was followed by discussions from the various members on this subject which was entered into very heartily.

The report of the secretary, Chas. E. Sims, was read, as well as the report of the treasurer, Geo. F. Keil.

The election of officers then followed. President L. L. Bingham, who has so faithfully served the association, felt that he had so many other duties to occupy his time and attention that he would be obliged to retire from his office. P. H. Atwood, Armstrong, Ia., was elected to the office of president. The other officers elected were: Vice-president, D. G. Keith, Ceylon, Minn.; secretary, Chas. E. Sims, Worthington, Minn., and treasurer, Geo. F. Keil, Sherburne, Minn.

The session then adjourned.

February 23, Afternoon Session.

The meeting was called to order by President Bingham at 2 o'clock. The first on the program was a paper by Geo. F. Sokol, Sibley, Ia.

W. G. Middleton, Emmetsburg, Ia., was then called upon to answer objections to the use of concrete tile, which he did in a very excellent manner, though the only objections to concrete tile are those raised by competitive manufacturers. He told of arguments

that are raised by the manufacturers of other tile products and the result of some of his findings.

Frank M. Okey, who has charge of the testing laboratory of the State University at Ames, Ia., was in the audience and President Bingham called upon him for a few remarks. Mr. Okey is an enthusiastic cement advocate. He gave a very comprehensive talk on how tests are made to determine the various properties of concrete. He said that set rules in proportions do not stand. In manufacturing concrete of any kind he believed that just as much water as could possibly be put into the concrete in order to make it stand up is the proper way to manufacture it. Following his remarks, he was asked a number of questions and his opinion of various statements that had been made at this and other sessions of the association. In regard to steam curing, he said he believed that better results could be obtained by turning live steam under pressure into the curing room.

C. F. Hunt, Lafayette, Ind., was then called upon for a talk on "Should Concrete Tile Be Dense or Porous?" Mr. Hunt is a strong advocate of porous tile and he backed up his statements very emphatically by giving some figures that had been given him by various customers of his in Indiana.

CEMENT AND ENGINE NEWS.

The St. Louis Portland Cement Company of St. Louis, Mo., have purchased a Mammoth McCully crusher, 42" opening with 54" pan conveyors, belt conveyors and accessories for their Ft. Bellefontaine, Mo., quarry. All of the machinery being furnished by the Power and Mining Machinery Company of Cudahy, Wis., a suburb of Milwaukee.

* * *

The Doolittle & Wilcox Co., Ltd., of Dundas, Ontario, large producers of crushed stone, have purchased from the Power & Mining Machinery Company one of their Mammoth McCully crushers with 42" opening.

* * *

The S. B. Martin Co., Fiborn, Mich., have purchased from the Power & Mining Machinery Company a Mammoth McCully crusher, 42" opening, 1-60" pan conveyor, 7' dia. screens, elevators and other equipment for a 10,000 ton daily capacity fluxing plant.

* * *

The C. & N. W. Ry. have just ordered from the Power & Mining Machinery Company a No. 11 McCully crusher with 27" opening and complete equipment for a crushing plant to be located at Cedar Rapids, Iowa.

* * *

Dolese Bros. Company, of Chicago, are installing a McCully crusher with 27" receiving opening, which is being furnished by the Power & Mining Machinery Co.

* * *

The Rock Cut Stone Company of Buffalo, N. Y., have purchased a No. 10 McCully and 7' diameter Screen from the Power & Mining Machinery Co.

CONCRETE-STEEL CAISSONS; THEIR DEVELOPEMENT AND USE FOR BREAK-WATERS, PIERS AND REVETMENTS.

By W. V. Judson, Major, Corps of Engineers, U. S. Army. Mem. Soc. C. E.

In the following we publish an abstract of a very interesting paper read before the Western Society of Engineers. In doing so we make no effort to bring out all the details of design and cost data, but merely wish to give the reader a superficial idea of the value of the publication. All details can be secured by addressing the Western Society of Engineers, Monadnock Block, Chicago, and asking for a complete copy of the paper. The cuts accompanying our abstract of the paper, show the general aspects of the work done. In addition to a description of the making and launching of the caissons, the paper contains a number of appendices, giving itemized calculations, and cost data, which will undoubtedly be of great value to every engineer sufficiently interested in this class of construction work:

For some time work has been progressing in this district (Milwaukee) which has involved the study, design and construction of reinforced concrete caissons for various structures. This system of construction has proved so efficient and economical, and the studies have been so promising that a full account of the work seems desirable.

No dry dock is available in which to construct the caissons, and the development of the latter has been influenced by the fact that the caissons must be built on ways and launched therefrom like any vessel. The heaviest caissons launched have weighed about 119 tons each, but caissons weighing 352 tons each will be built and launched at Milwaukee next summer, and there is no reason to doubt that much heavier caissons can be launched with perfect facility.

The ways that have been employed consist each of three 12 in. by 12 in. stringers, descending into the water with a slope of one on ten. With this slope the caissons start of themselves and do not bind. The stringers are supported on capped pile bents, extend far enough back to give building space, and terminate about six feet under water.

The caisson is begun upon a plank floor, 3 in. or 4 in. thick, which is launched with and forms a part of the caisson. Spikes are driven through the plank so as to project upward into the concrete, and building paper is pressed down upon the plank to reduce the leakage. A temporary wooden deck is used while launching and while towing any considerable distance in the open lake. A caisson is designed so as to have its width and depth proportionate to the work it is to do in a breakwater or pier. Its length is limited partly by the undesirability of too great aggregate weight, but more by the consideration of longitudinal strength, considering the whole caisson as a beam upon which various stresses may be brought to bear under different assumptions as to character of foundations. The reinforced concrete walls, bottom and cross-walls are limited in thickness by considerations of buoyancy, but within the limits of buoyancy it is practicable to design with reasonable economy.

Whether in a given caisson to employ thick walls and few chambers or thin walls and many chambers is a question, in solving which careful judgment should be employed. With thick walls and few of them the cost of putting the reinforced concrete in

place is reduced. On the other hand with more numerous walls the spans are reduced and the caisson even with thinner walls sometimes is a safer structure.

In some cases it would probably be advantageous to substitute interior bracing for some of the cross walls.

In the general case small caissons, say 14 feet square in plan, such as I am using for a number of light-house structures, must be monocellular, for the reason that, if they were divided up, considerations of buoyancy would require the use of such thin walls that excessive care would be required in their construction, and the steel if sufficiently embedded would be too near the center of the walls.

On the other hand, in the case of large caissons, such as the one 60 feet square in plan, hereinafter alluded to, it is best to have numerous chambers, inasmuch as the cross walls, even if there are many of them, may still be of reasonable thickness. It is not believed that in many cases it would be true economy to use caissons which would be lighter in weight than conditions of buoyancy require.

The stresses brought upon a caisson are ordinarily as follows: those due to water pressure upon the outside; those arising from excess of pressure, due to the filling, outward; those due to bending, if the foundation be imperfect and the caisson be supported, for example, under its two ends, or under its middle; and those due to wave action.

When the caisson is launched it may be but ten days old, and the concrete relatively green. When launched, unless long and expensive ways are employed, the caisson plunges low in the water, and the pressure due to the latter is at a maximum.

It is generally found that if the walls and the steel therein be proportioned to care for this initial pressure safely, then the other stresses are negligible, although investigation should always be made as to the sufficiency of the longitudinal strength.

In designing caisson walls and bottoms, several methods have been employed. For a time, following Merriman ("Mechanics of Materials," 10th Edition, 1905), the steel near the surfaces of the walls has been assumed to take up all the tension and compression, the neutral axis to be in the center of the wall, and the concrete to serve only as the web of the beam. Later the more correct and economical theory has been applied, that the steel on the tension side takes up all the tension, while the steel on the other side reinforces the concrete in compression from the neutral axis up. The horizontal steel reinforcement employed in the walls has been distributed in equal amounts on each side of the neutral axis.

Deformed bars are preferred, as plain bars might not form a sufficient bond with the green concrete.

From study and experiment it is believed that the horizontal steel rods in a wall may be proportioned as follows: Assume a reasonable thickness for the wall dependent upon flotation desired, etc., say from 12 to 16 inches. Consider the wall as a series of discontinuous beams, one above the other, each with a distributed load corresponding to an assumed maximum water pressure. Take the span in the clear without allowance for the filling in of the corners where walls meet (this gives a factor of safety). Neglect the facts that the wall is a slab, due to the presence of vertical rods, and that it is a continuous beam (these give additional factors of safety). Then proportion the steel in accordance with the formulae stated on page 117, Proceedings of the Am. Soc. C. E. for Feb., 1909, allowing the steel in tension to be



View 5.
Reinforced Concrete Caissons for Algoma Breakwater, being launched.



View 6.
Reinforced Concrete Caissons afloat in Algoma Harbor.



View 7.
Reinforced Concrete Caissons for Algoma Harbor.



View 8.
Reinforced Concrete Caissons at Algoma Harbor
—filling and sinking with water, by syphons.



View 9.
Reinforced Concrete Caissons—in place, Algoma Harbor—and partly
filled with rip-rap stone.



View 10.
Reinforced Concrete Caissons—Algoma Harbor, in
place—with top filling of concrete, being placed.

strained to 18,000 pounds per square inch. Mr. Howard A. Hoenig of this office has prepared from these formulae diagrams by means of which a graphical solution of any ordinary problem of this character can be quickly made.

In the walls a certain number of rods are introduced vertically. They have generally been placed in pairs, spaced 2 feet apart. The vertical rods add somewhat to the strength of the walls, and reinforce against diagonal tension, considering the caisson as a single beam. They also serve as supports for the horizontal rods in forming.

The steel in the bottom is determined as in the case of a wall. If the caisson is to be placed on a pile foundation, the principal system of rods ordinarily runs longitudinally to support the filling from one pile bent to another. For use on an enrockment the principal rods in the bottom are ordinarily placed transversely. In the bottom, as in the walls, the rods are placed in pairs, one rod near each surface, and again as in the walls, a lighter system of rods is employed at right angles to the main system.

Wherever walls come together, the re-entrant angles are filled in with concrete, as shown on the Plates, and short rods are inserted in these angles to stiffen them.

Inasmuch as no records were available where beams with equal reinforcement top and bottom, and of concrete but ten days old, have been tested to destruction, a few tests of this character have been made. The results of these tests confirm the belief that the method of designing above described will give reasonable factors of safety, which will be increased somewhat by other considerations that have already been mentioned.

The experimental tests indicate that failures due to compression in the concrete need not be apprehended except where the percentage of reinforcement is very large, larger in fact than would ordinarily be employed in caissons following the method of designing proposed. Where the shear is great, however, there should be an investigation as to the sufficiency of the resistance to diagonal tension stresses.

Appendix II, prepared by Mr. J. A. B. Tompkins, Assistant Engineer, describes and analyzes the tests above mentioned and states the formulae recommended by the special committee of the Am. Soc. C. E., which are applicable to the work under consideration. Among the formulae are those for compression in extreme fiber of concrete and for diagonal tension. Considering all of the conditions and the results of the tests, it would appear that at time of launching compressive stresses on extreme concrete fiber up to 1,000 pounds per square inch and diagonal tension stresses up to 50 pounds per square inch, both as determined by the formulae, where the caisson walls are designed as herein proposed, would not be excessive.

At the time the caissons are launched, any failure would probably result from failure in the green concrete in portions of a wall where the percentage of steel is greatest, or from tension failures in the steel where the percentage of reinforcement is small. But as the concrete rapidly gains in strength, such designing as I have described would make the walls, after the lapse of time, much stronger, and where the percentage of steel is greatest, approximately equally liable to yield through tension or compression failures. It appears therefore advisable to use steel with a high elastic limit, the gain being most noticeable on portions of a wall where the percentages of steel are relatively small.

A method employed for investigating the longitudinal stiffness of a caisson is shown on Plate III.

The 54-ft. Milwaukee caisson has been chosen for purposes of illustration. As this caisson is designed to be supported on four bents of piling, the assumption is made that one of the end bents is cut off too low to perform its function. One-third of the caisson would then be unsupported and would act as a cantilever, bringing the steel near the top of the caisson into tension. Assuming that the concrete serves no function except to unite the steel rods and make them act together, the steel is projected into a beam, under the assumption that all the steel in a given horizontal plane is united together to form part of a flange or web. The maximum bending moment is applied to this hypothetical beam and the tension in the extreme fiber thus determined is assumed to be the tension in the steel rods near the top of caisson.

No difficulty has been experienced in securing water-tight walls. The caissons are constructed of 1:2:4 concrete and the latter is ordinarily dense enough without treatment. However, the caissons, on the ways, have as a rule been partially filled with water, to test water-tightness, and in some cases a grout wash, containing lye and alum, has been applied to the exterior.

One of the first thoughts that arose, when the permanent filling of the caissons was under consideration, was as to the effect of interior freezing. In the autumn of 1907 a small caisson, 7 feet long, 5.81 feet wide, and 5.67 feet high, with bottom and walls varying in thickness from 4 to 5 inches, was built on the Government dock at Milwaukee, Wis., tumbled off the dock into the water, thus falling 6 feet, towed to the mouth of the harbor, beached in 3.8 feet of water in an exposed location on North Point, filled with sand, and paved over with 6 inches of concrete. This caisson, which is still in place, has not moved perceptibly nor suffered damage from any cause whatever.

The first caissons for actual service were built by days labor at Kewaunee harbor, Wis., during the summer of 1908. They were used in constructing a breakwater at Algoma harbor, Wis.

The caissons, 24 feet long (or 25 feet long with the guide timbers), 15 feet wide and 12 feet 4 inches high, with walls 12 inches thick, one cross-wall 10 inches thick and a bottom 16 inches thick (not including the 4-inch thickness of plank bottom-, weighed 119 tons each in air. They were constructed on ways, of which three sets were provided, at the rate of one every third day after organization was completed. There were no difficulties encountered in any part of the work. The caissons, temporarily decked, were launched and towed 12 miles in the open lake to Algoma harbor, Wis., where the decks were removed and the caissons packed until they could conveniently be placed in the work. When launched, as the ways terminated but 6 feet below datum, the caissons tilted forward until the decks made an angle of about 30 degrees with the water surface, and sunk until they were just submerged. They immediately righted themselves and floated with a draft of 9.7 feet, corresponding to a freeboard of 2.63 feet.

At Algoma the arm of the breakwater constructed of caissons was 511.7 feet long. The natural depth varied from 15.3 to 13.5 feet. The breakwater faces approximately south-east by south and is exposed to a fetch of about 140 miles measured normally to the breakwater.

At Algoma the caissons were sunk on a pile foundation so as to project one foot above datum when placed. Intermediate between the pile tops and the plank bottoms of the caissons were cast iron disks.

covering the pile tops and placed upon them, of course, before the caissons were sunk. These disks were cast with waffle patterns on each side, so that the corrugations, being pressed down into the piles and up into the plank bottom, would introduce a desirable amount of friction and at the same time somewhat equalize the loads on the piles. The initial sinking was by means of water, introduced through syphons. The caissons, except several that were filled otherwise for experimental purposes and which will be hereinafter described, were then filled with broken stone to within 4 feet of the tops. The rest of the filling was of lean concrete, and the breakwater was completed by riprapping its sides and adding a concrete superstructure.

I cannot speak too highly of the services of Mr. L. E. Lion, Assistant Engineer, who was in local charge of the work. That this undertaking, when so much was novel, progressed so smoothly was largely due to his skill and careful foresight. Appendix III is a report by Mr. Lion describing all the details of the work. His analyses of cost are especially complete and valuable.

Before the Algoma breakwater was commenced it was estimated that its cost, if built of stone-filled wooden cribs of the type usually employed on this lake, the same being placed on pile foundation and

was obtained from the demolition of the old south pier. It therefore appears that the saving on the Algoma breakwater, due to the use of the caissons, was \$26.89 per lineal foot, or 25.57%.

Incidentally it may be said that for the construction of the harbor at Algoma there was available on Jan. 1, 1908, \$44,822 cash, with \$100,000 additional authorized and subsequently appropriated. This was considered but a fair allowance for the work projected, if done by contract, and in fact the prices bid by contractors, after formal advertisement, were so large that the cost would have exceeded the amount available. Using Government plant and days labor, the harbor is now completed, except for dredging 20,000 cubic yards, more or less, and depositing about the pile pier 700 tons more or less, or riprap, and after this small amount of work is completed in the spring there will remain of the amount originally available at least \$45,000.

APPENDIX III.

Description of Algoma Caisson Work.

By Mr. L. E. Lion, U. S. Asst. Engineer, M. Am. Soc. C. E.

The river and harbor act of March 2, 1907, contained the following item: "Improving harbor at



View 11.

Reinforced Concrete Caissons—Breakwater at Algoma Harbor—top filling of Concrete from mixer on scow—also showing manholes in concrete top.



View 12.

Finished—Reinforced Concrete, Caisson construction—Breakwater at Algoma Harbor.

capped with a standard concrete superstructure, would be \$105.18 per lineal foot, and this was the cheapest way, following former practice, in which the breakwater could have been built in permanent form. The estimate for the caisson breakwater was \$103.74 per lineal foot, large unit prices having been purposely assumed because of the novelty of the work. The actual cost of the work proved to be but \$75.67 per lineal foot, although there should be added to this, to make the estimates fairly comparable; \$2.62 per lineal foot to allow for the saving on riprap stone that

Algoma (Ahnapee), Wisconsin, by the construction of an outer harbor with a depth of sixteen feet of water, \$40,000; Provided, that the Secretary of War may enter into a contract or contracts for such materials and work as may be necessary to complete such project, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate \$100,000, exclusive of the amounts herein and heretofore appropriated."

During May and June, 1907, a survey and examination, including many borings, were made on which

to base a design for Algoma harbor. After considerable study of the data obtained, it was decided to build a small outer harbor in Lake Michigan, immediately south of the then existing harbor entrance, as shown on Plate IV.

The project embraced 511.7 linear feet of reinforced concrete breakwater, 733.7 linear feet of pile pier, 200 linear feet of plank cribs and about 115,000 cubic yards of dredging. In addition 550 linear feet of the old south pier were to be removed, and the north pier was to be repaired by the renewal of four courses of timber in the superstructure.

The cost of this work, including supervision and contingencies was estimated at \$142,000, which was slightly in excess of the amount available, but there was a small balance on hand for maintenance under which the repairs to the north pier properly came.

The portion of the breakwater most exposed to the action of waves consisted of 511.7 linear feet of reinforced concrete breakwater, made up of twenty reinforced concrete caissons of 1-2-4 concrete resting on a pile foundation and surmounted by a solid concrete superstructure. Each caisson was 24 feet in length, 15 feet wide, and 12 feet, 4 inches in height, with sides and end walls 12 inches in thickness and bottom 20 inches in thickness, 16 of which were of concrete and 4 of timber studded with 8-inch spikes. A transverse wall 10 inches in thickness, divided each caisson into two cells. The caissons were reinforced with deformed bars of the Johnson type made of mild steel and were designed to withstand water pressure from the outside while afloat and to retain the filling after being put in place. Reinforcement was also provided to give ample strength to resist the stresses of launching, handling, or unequal bearing on the foundation.

The reinforcing steel in the walls was proportioned according to the method given by Mansfield Merriam in "Mechanics of Materials," 10th Edition, page 286, the steel being assumed to carry all of the tension and compression while the concrete was assumed to act only as a spacing medium and bear the stresses which would be carried by the web of a girder. While this method gives an excess of steel it was thought advisable to use it on account of the early age at which the concrete would receive its launching stresses. The steel in the bottom of the caissons was proportioned according to the method given in Taylor and Thompson's "Concrete Plain and Reinforced," first edition, page 563. In order to provide for possible errors in the cutoff of foundation piles, sufficient steel was also placed in the caissons to enable them to carry safely their own weight and load due to filling, if supported only at the ends or at the center.

A foundation of eighteen piles supported each caisson, the piles being cut off eleven feet, four inches below datum. Riprap stone was used for filling the caissons to within four feet of the top, the upper four feet of the filling being of 1-5-10 concrete. In order to facilitate correct sinking, two guide timbers 12 in. by 12 in. and 11 feet, and 4 in. long, were bolted to each end of the caissons, making an interval of 1 foot between each caisson. This interval was afterwards filled with small stone, and capped with a slab of 1-3-5 concrete 1 foot in thickness.

The superstructure which topped the caissons was built of 1-3-5 mass concrete, and was carried to an elevation of 4 feet above datum. It covered 9 feet 6 inches of the 15 feet of width of caissons and was approximately trapezoidal in cross-section, having a slope of 1 on 2½ on the lake side, and an almost vertical face on the harbor side. The caissons were protected by riprap on both the lake and harbor sides to within 4 feet of datum, large stone being used on the

outside. A cross-section of the breakwater and a horizontal section of one of the caissons are shown on Plate V.

In answer to an advertisement for proposals for building the entire breakwater, the following bids were received. All timber, except caisson bottoms and piles, together with steel reinforcing bars were to be furnished by the United States and were therefore not included in the prices bid:

Thos. H. Smith, Sturgeon Bay, Wis. Bid: \$50,122.50 on Concrete Breakwater only.

Great Lakes Dredge & Dock Co., Chicago,

Ill.	\$120,166.00
Adolph Green, Green Bay, Wis.....	110,380.50
Greiling Bros., Green Bay, Wis.....	104,057.00
Estimated cost	92,490.00
Amount available for this part of the work	94,000.00

The lowest bid was that of Greiling Bros., of Green Bay, Wis., which was \$11,567 in excess of the estimated cost, and \$10,057 in excess of the amount available after making due allowance for contingencies, supervision, materials to be furnished, and repairs to the north pier.

All bids were therefore rejected and it was determined to execute the work by hired labor. Steps were immediately taken for the purchase of the necessary tools and materials and to begin work as soon as weather conditions permitted.

Contracts for piles, timber and reinforcing bars had previously been entered into, to supply the contractor under the proposed contract.

The United States yard at Kewaunee, Wis., was selected as the most advantageous point at which to build the reinforced concrete caissons. At Algoma, Wis., the small depth of water and rock bottom inside of the harbor would have made launching caissons hazardous, and the fact that an equal number of caissons were needed for Manitowoc, Wis., made it evident that one plant to serve both Algoma, Wis., and Manitowoc, Wis., was more advantageous to the United States, than the establishment of two separate plants. Moreover, the United States owned a yard and warehouse at Kewaunee, Wis., where the construction of a permanent set of ways for hauling floating plant out of water was a desirable and necessary improvement for the maintenance of floating property. The water bordering on Government yards at Kewaunee is free from waves and currents, being on an old branch of the Kewaunee river, and while the depth of water was not sufficient, a small amount of dredging made it ample. Kewaunee, Wis., is 12 miles south of Algoma, Wis., and 30 miles north of Manitowoc, Wis.

Work was begun at the yard on March 12, 1908, by the erection of a warehouse for the storage of cement. As the weather moderated work was gradually extended to the launching ways and forms for the caissons. All parts of the plant were installed by June 1, 1908, when the actual construction of caissons was begun.

Launching Ways.

Three sets of launching ways were built for launching the reinforced concrete caissons. Each set of ways was 24 feet wide and 103 feet long, terminating under water at a depth of 6 feet below datum. There was a clear space of 10 feet between each set of ways. The piles supporting the ways were spaced to sustain a load of 15 tons to the pile, and were driven in bents of three piles. Each bent was capped with 12 in. by 12 in. timbers, 24 feet long. Three longitudinal tim-

bers, 12 in. by 12 in., placed at an inclination of 1 on 10, formed each set of fixed ways. The caps were drift-bolted to the piles, and the fixed ways to the caps. The gage of the ways in the clear was 22 feet. The computed weight of each caisson was 119 tons; the area of sliding ways on the fixed ways was 45 square feet, making the load per square foot 2.65 tons.

The cost of the launching ways was \$3,684.52, which includes all labor and materials.

Forms.

The forms were made in three distinct parts, the outside forms, the inside forms or core, and the trusses for holding the forms rigidly in place.

All lumber used was Oregon fir, dressed on all sides and edges. The lagging was of 2-inch boards, placed horizontally and bolted to 2 in. by 6 in. studding. Each side and end of the outside form was made in three sections to facilitate handling and placing. In the core forms each side and end was made in one piece. Six by six struts were used inside of the core for bracing, and twenty trusses, ten to a side, each truss stiffened with a $\frac{7}{8}$ in. iron rod and turnbuckle for tightening, were used for stiffening the outside forms. The trusses were so built and placed that through the use of 3 in. by 12 in. boards on edge across the ends, the entire outside form was rigidly girdled and held in place. One set of trusses and braces served the three forms. The accompanying photographs will give a clear idea of the trusses and forms.

Three sets of forms were built at a total cost of \$1,839.57. After completing the Algoma caissons these forms were slightly modified and used in the construction of 22 Manitowoc caissons. They are still in serviceable condition.

Plant.

The launching ways, previously described, formed of course the most important part of the plant. In the rear of the launching ways a traveling derrick of 3 tons capacity with a 50-foot boom, ran on a track of 28-foot gauge parallel to the back of the ways. This derrick was so placed that it could handle the forms, steel, and concrete on any of the ways. A number "2½ Smith" concrete mixer was mounted behind the derrick so as to be easily moved by means of rollers on longitudinal timbers placed between the derrick tracks. The mixer engine received steam from the derrick boiler. In the rear of the concrete mixer and secured to the same frame as the mixer was a small auxiliary derrick which was used only for handling the broken stone and sand, which is lifted in skips from small flat cars, and dumped into a hopper immediately over and behind the mixer. This derrick was operated by a Manila line running to a winch head on the hoisting engine of the traveling derrick.

A double narrow-gauge track ran from the storage pile of aggregates to the mixer. The materials were shoveled into and proportioned in metal skips on flat cars. Two cars were used, one on each track, and were propelled by the men who loaded them.

A temporary warehouse for the storage of cement, 25 feet by 50 feet, was built parallel to the tracks so as to be near the mixer.

Water was supplied to the entire yard by means of a 2½ H. P. gasoline engine, and a 5 in. by 5 in. double acting belt driven force pump, which pumped the water into a galvanized iron tank mounted on a trestle over the pump house. A 2-inch water main distributed the water to the mixer, hoisting engine and other parts of the yard.

Besides the above plant, a blacksmith shop, cement

testing laboratory, office and warehouse for miscellaneous storage were already on the ground and were used on this work. Many small tools were also purchased for the work.

The entire cost of the plant and installation, exclusive of the cost of the launching ways and cement warehouse, was \$5,778.27. The cement warehouse cost \$521.40.

Setting Up Forms and Placing of Steel.

The forms were set up over the launching ways. Blocks about 12 in. by 12 in. by 6 in., which were easily split with splitting wedges, were placed on the pile caps of the ways, in order to secure a level support for the 12 in. by 12 in. timbers on which the bottom and forming were placed. Short blocks, capable of being easily split with wedges were used, as this was the means employed for lowering the caissons on the sliding shoes at the time of launching.

After carefully leveling the timbers on which the form was to rest, 4 in. by 12 in. timbers 24 feet long, through which 8 in. wire spikes had previously been driven, were placed in position on the supporting 12 in. by 12 in. timbers to form the bottom of the caissons. The 8-inch spikes became firmly imbedded in the concrete, thus binding securely the wood bottom and the concrete.

The lower layer of reinforcement was now put in place. The rods were kept above the wood bottom by small rods running perpendicular to the reinforcement and kept at the correct elevation by means of pebbles.

In later work it was found advantageous to place a layer of building paper over the wood bottoms in order to prevent the escape of mortar and cement from the concrete through the cracks in the bottom. This escape of mortar, while not great, seemed to render the bottom porous in places and caused some leaks, which, while not serious, were annoying. The use of the building paper improved the water-tightness of the bottom.

Iron brackets for supporting the core were now put in place. These were made of $\frac{3}{8}$ in. by 1½ in. mild steel bent into the shape shown in Fig. 3, Plate VI.

Eight of these brackets supported each core. Sixteen constituted a set, as there were two cores to a caisson. The brackets remained in the concrete.

The brackets being placed, the cores were now erected, together with their inside braces, which consisted of eighty struts of 6 in. by 6 in. Oregon fir. After the cores were erected and in proper position, beams of 4 in. by 6 in. timber were placed across the top of the cores and bolted thereto, for the purpose of suspending the wall reinforcement.

When the cores and bracing inside of the cores were in place, the upper layer of reinforcement in the bottom was put in position. This rested on bars suspended from the core braces at right angles to the direction of the reinforcement. Where the reinforcing bars crossed the supporting bars, these were wired together with No. 20 wire, so as to prevent displacement in depositing concrete.

While the bottom, core forms, and bottom steel were being put in place, the reinforcement for the walls was being prepared for the work by threading through holes punched to the proper spacing in steel flats, 1/16 in. by 2 in. By using three spacing flats for each vertical row of bars, a unit of reinforcement was formed which was readily lifted into place by the derrick and suspended from beams supported by the core. The upright reinforcing bars were wired to the horizontals before the unit was bolted in place. All of the reinforcement in the walls was put in place in

this manner, except the short bars at the corners. These were wired to the horizontal bars in place.

All of the steel now being in place, the outside forming was erected, the four walls being brought up simultaneously. This forming was held in place by ten sets of trusses and boards on edge which locked around the form, and held it rigidly in place and prevented yielding as the trusses were so designed as to take up all of the pressure which was brought to the outside forms by the wet and unset concrete. All examination of the photographs (views 1 to 4 inclusive) will make clear the form construction and method of bracing the forms.

Method of Molding.

It was endeavored to mold each caisson at one continuous operation, in order to secure a perfect monolith and thus lessen the danger of leaks. All of the caissons were successfully molded at one operation, except the first one, which required two days on account of a change which was found necessary in the arrangement of the plant. No leaks developed in the caisson which was molded in two days.

A temporary platform with two hatches, one in the center of each core, was placed over the core forming. The concrete mixed to a very wet consistency was dumped through the hatches into the bottom and near the edges of the platform in molding the walls. The concrete was shoveled from the platform into the walls and puddled thoroughly by means of long sticks. Puddling of the bottom was effected by laborers working inside of the core. The bottom was placed first, and then the sides, ends and cross-walls were brought up simultaneously.

The aggregates were shoveled into skips resting on small flat cars at the stock pile. The cars were then run over the narrow gauge track to the derrick in the rear of the mixer which raised the skips and dumped them into the mixer hopper. The cement was added in the hopper. Each batch consisted of 2 bags of cement, 4 cubic feet of crusher dust and 8 cubic feet of 1 in. broken stone. A barrel so arranged as to measure the water used in mixing the concrete, rested on the platform above the mixer, and was operated by a lever by the man on the mixer platform. The concrete was given about 14 turns in the mixer, and then dumped directly into a bottom dumping bucket, which was handled by the traveling derrick.

An average of 281.6 bags of cement were used in each caisson, making 1,347 barrels of cement to every cubic yard of concrete.

As a rule seven hours were required for molding a caisson, or 7.46 cubic yards per hour.

The quantity and cost of materials in a caisson averaged as follows:

Stone and Sand, 52.21 cu. yds., at \$1.25.....	\$ 65.26
Cement; 70.4 bbls., at \$1.15.....	80.96
Reinforcing Bars, 12,967 lbs., at 1.92 cts.....	248.97
Bolts	15.59
Timber	66.65
Spikes and Wire.....	4.54
Brackets	76.53
Flats	69.82

Total.....\$628.32

The force employed in molding was usually as follows:

1 Foreman at \$120 per month.....	\$ 4.00
1 Engineman at \$80 per month.....	2.67
1 Fireman at \$60 per month.....	2.00
1 man operating small derrick, at \$2.25 per day	2.25

2 men carrying cement, at \$1.75 per day.....	3.50
1 man on mixer platform, at \$2 per day.....	2.00
1 man dumping mixer, at \$2.....	2.00
6 men at stock pile and transporting aggregates, at \$1.75 per day	10.50
2 men placing concrete in forms, at \$2.25 per day	4.50
6 men puddling, at \$1.75 per day.....	10.50
—	—
22 men.....	\$43.92

This same force was employed in setting up forms, placing steel, and all other work pertaining to caisson construction.

Removal of Forms.

The inside and outside bracing were removed when the concrete was 24 hours old, and the forms whenever convenient, after the concrete was 48 hours old. No difficulty was experienced in the removal of forms, nor did any material adhere to the forms so as to leave a disfigured surface, although they were not coated with any preparation.

Waterproofing.

Within two days after the removal of the forms, the outside of the caissons were given a wash of thin grout made of neat cement. This wash was applied and rubbed well into the surface of the concrete with a whitewash brush. After the cement had dried, two coats of the following wash were applied:

One pound of concentrated lye and five pounds of alum were added to 2 gallons of water, care being taken that every particle was dissolved. This constituted the "stock." To one pint of the "stock" was added 10 pounds of cement, and water until the mixture was of such a consistency as to spread easily on the walls with a brush. Usually 1 pint of stock was put into a 12-quart bucket, and 10 pounds of cement stirred in with enough water added to fill the bucket. This recipe was obtained from the Report of the Chief of Engineers, 1902, Part 3, page 2,482, in which it is described by Assistant U. S. Engineer G. B. Hegardt.

With the small heads of water of 9 to 10 feet against the caissons when afloat, no difficulty was experienced in obtaining water-tight walls, and it is thought that the walls would have been impervious without the application of any preparation. As the cost of this mixture was very small, it was put on the caissons as a precaution against leakage.

All caissons were tested for leaks before applying the waterproofing wash by pumping about 6 feet of water into each one. This was syphoned out before the application of the wash.

Launching.

Before launching, temporary timber decks were placed on the caissons for the purpose of excluding water during towing and launching. These were made in four sections of 2-in. Oregon fir, with all seams tightly calked and provided with ring-bolts for lifting the sections into and out of position. In order to shorten the span of the deck planks, and add to their rigidity and supporting power, 6 in. by 6 in. timbers were placed longitudinally across the inside of the caissons near the top, and rested on the imbedded timbers and on the cross-wall. These timbers were supported in the middle by 6 in. by 6 in. columns, resting on the caisson bottom. For convenience in removing, lag screws were used for fastening the deck to the imbedded timbers. Two small hatches were

placed in each deck for purposes of inspection. Before launching or towing the hatches were fastened down securely, and all joints around hatches and between the concrete and deck were carefully calked. A total of four decks sufficed for the entire work.

The 12 in. by 12 in. guide timbers shown in the drawings were bolted to the caisson ends, bolts having been imbedded in the concrete for this purpose.

Three sliding shoes for launching were used under each caisson at the time of launching. These were made as shown on Plate VII, with an oak sliding surface and Oregon fir filling above. The outside shoes were provided with rib-bands on the inside only. The middle shoe had no rib-bands at all. The shoes were lubricated with beef tallow just before launching and then driven tightly under the caisson bottoms. An inclined shore placed against the sliding shoes in front of the caissons, together with a tripping lock on each side of the ways, held the caisson and sliding shoes in place while the weight of the caisson was being transferred from the stocks to the sliding shoes.

In order to take the load off the stocks, the small blocks supporting the 12 in. by 12 in. timbers on which the caisson rested, were split with steel splitting wedges, thus allowing the caisson gradually to settle upon the shoes. The small blocks having been cut out, the 12 in. by 12 in. timbers or stocks were removed, and the caisson was ready for launching (see Plate VII).

The ways having been freshly greased with tallow, men were stationed at the shores and tripping keys. At a signal previously agreed upon, the shores were knocked out with sledges, and at a second signal the tripping device on each side was tripped, releasing the caisson, which started by its own weight. All of the caissons moved readily as soon as released and traveled the entire length of the ways without binding in any way. The velocity of travel averaged 8.6 feet per second. The launching of a caisson is illustrated in View 5.

As the ways terminated at a depth of six feet below water, and the draft of the caissons was about 9.7 feet, the caissons tilted and submerged themselves on leaving the ways, as they had a fall of about 3.7 feet in water. However, they righted themselves immediately and came to the surface on an even keel. Every launching was satisfactory in all respects.

A caisson having been launched it was prepared for towing by wrapping around it a girdle chain to which the towing hawser was made fast.

The small fishing tug "Southern Cross" towed all of the caissons from Kewaunee, Wis., to Algoma, Wis., a distance of 12 miles from pier to pier. This boat is 56 feet in length, and of 25 gross tonnage. Her engines are 10 in. by 12 in., and her boiler carries 100 pounds of steam.

The time of towing was usually from 6 to 7 hours or at the rate of a little less than 2 miles per hour. As a rule the tug took but one caisson at a time, but on two occasions she took two at a tow, and handled them as well as one, although the time of towing was a little greater.

The cost of towing was \$20 per caisson at first and later \$23 per caisson, which included the return of the temporary decks. As the total cost of towing was \$442, the cost of towing per cubic yard amounted to \$0.423.

Storing.

The caissons were stored afloat at Algoma until they were needed in the work (View 6). The decks were removed as soon as received and returned to the molding plant at Kewaunee, where they were used

over and over. No trouble was experienced in keeping caissons afloat for weeks at a time, their impermeability being such that no pumping whatever was required.

Breakwater Foundation.

The foundation consisted of piles driven to a firm bearing and when practicable to rock. Piles 40 feet long were used and were cut off at a depth of 11 ft. 4 in. below datum. As the piles generally stood about 4 feet above datum when the desired resistance was attained, a penetration of about 25 feet was obtained. The space around the piles was filled with riprap stone which was carefully leveled off by a diver about 9 in. below the pile tops.

A swinging "A" shaped saw-frame having a radius of 16 feet, and pivoted above water on the pile being cut, was used for cutting off the piles. An ordinary cross-cut saw was fastened to the lower end of the frame, and the saw drawn back and forth by men on rafts hauling on lines attached to the lower end of the saw-frame. Errors in cutting off which were lower than the desired elevation were corrected by placing shims of the proper thickness under an iron casting with suitably roughened upper and lower surfaces designed to equalize the bearing and introduce friction (see Fig. 2, Plate VI). The error of cut-off was intentionally kept low, and it was not found necessary to re-cut any piles on account of their being too high. The floating stages on which the men worked were made of 12 in. by 12 in. by 20 ft. timbers held together by scantlings spiked across their tops.

Sinking and Filling Caissons.

About 100 feet of foundation were prepared at a time, and when this was in readiness, four caissons were sunk. The sinking was effected by syphoning water into the caissons by hanging 2 in. syphons over the wall (Views 7 and 8). In order to start a syphon it was first filled with water and a wooden plug having a handle was inserted in each end. The two plugs were released at the same time and the flow of water thus started. From twelve to fourteen syphons were used to expediate the sinking.

Each caisson was put into exact position by securing one end to the previously sunk caisson and holding the farther end precisely in place by means of light blocks and tackle. An instrument-man with a transit observed the position of each caisson while being sunk and gave the necessary signals for keeping it on line. No difficulty was experienced in holding caissons on line or sinking in the desired position. Whenever a caisson was misplaced it was easily floated again by pumping out some of the water. A caisson having been sunk it was filled with riprap stone to within four feet of its top (View 9). It was generally found practicable to sink and fill with riprap four caissons in a day. The upper concrete filling was deposited soon after sinking. A layer of burlap was spread over the riprap to prevent mortar from running into the interstices between the stones, and the concrete placed on this (View 10). Two forms for manholes were placed in each caisson, one in each compartment as shown in the drawing. Before concreting, the water in the caissons was pumped down below the level of the riprap, so that the filling was deposited in air. The surface of the filling was given a smooth finish where no superstructure came over it. Under the superstructure the surface was left rough so as to bind more effectively with the superstructure which was subsequently added.

Before the caissons were sunk, eight pile tops were placed in the caissons in a vertical position to act as

supporting pillars for the concrete filling in case the riprap filling should settle away from the concrete.

Covers of reinforced concrete were molded in the manhole tops to close the openings (see Fig. 1, Plate VI).

A mixer mounted on a scow was used for mixing the concrete for the filling and for the superstructure. This mixer was set at an elevation which permitted dumping the mixed material directly from the mixer into a chute from which the wet mixture flowed into the work.

Intervals Between Caissons.

The intervals, 12 inches in width between caissons, were filled with small stone to within one foot of the top, and then covered with a 3 in. by 12 in. board, on which a filling of 1:3:5 concrete was placed. This filling was brought up to the top of the caissons, and given a finished surface the same as the caisson filling.

Superstructure.

A superstructure of 1:3:5 concrete of the form and dimensions shown on the drawings was built to an elevation of 4 feet above datum. The superstructure was built in sections 25 feet in length, the joint between sections being made coincident with the center of the interval between caissons. Alternate isolated sections were first molded and then the intermediate sections, a layer of building paper being placed between each section to provide against temperature changes. The concrete in the superstructure was deposited from a mixer on a scow in the same manner as the concrete filling (Views 11 and 12).

A GREAT INDUSTRY.

It is wonderful all the things you can do with concrete, and it is not surprising that in this day and age of specializing to find concerns which specialize in concrete machinery. But it is surprising to find a concern which specializes in the manufacture of these machines for others. We refer to the Northwestern Steel & Iron Works, Eau Claire, Wis., whose ad. appears on inside back cover of this issue.

So much has been written of late in the columns of concrete journals regarding the science of making good concrete blocks, that we believe a word regarding the science of making good concrete machinery would also be in order.

It is a wonderful experience to go through the plant of this factory which specializes in the making of concrete machines for jobbers, distributors and concrete concerns in general. As you go through their factory and see the army of men working here and there, you wonder where all the concrete machinery goes to, and we learn that many thousand machines and moulds are made up and shipped during each season.

When you enter the foundry, you realize that it is a master hand that controls the arteries of this great institution. You see pig iron of different grades, steel and wrought iron borings carefully graded and weighed to produce their famous "Concrete Machinery Mixture." You see molten metal pouring out of a furnace at white heat. You see dozens of men going and coming from this red monster carrying the melted iron to the individual moulds, which will soon be in the form of machinery, making blocks for building and ornamental work. The foreman, grim and bronzed, reflecting the red glare from the furnace, stands near, calculating by the color of the metal just when to close up the mouth of the furnace to renew the heat. In ordinary foundries the matter of heat is not so very important, but for the thin concrete plates,

the metal must be very fluid and, at the same time, of close texture and great strength and stiffness.

The moulds are still smoking when the forms are taken away and the castings taken to the grinding rooms to be smoothed up, bored, etc. Here, all is methodical. Each man has his own particular machine or grinder. Each man understands concrete from A to Z. Accurate and modern grinding machinery is the great necessity in concrete form construction—heavy edge and surface grinders, "slab" planers, cup and disk wheels, flexible shaft grinders, etc.

From the grinding rooms the castings are taken to the assembling and finishing rooms. Here again is the same exact, painstaking care used in selecting and assembling only the perfect plates. And so, when the machine itself is assembled, it is of the best construction possible. It has the clear-cut outline, the sharp plates, the symmetrical lines necessary to produce first-class concrete work.

The forge shop is equipped with 6 large furnaces, 3 drop hammers, 2 power "Helve" hammers, No. 6 Williams & White "Bulldozers," powerful gang punches, etc. It is here all the steel work and forgings are made. The company's plant covers a space of over 6,000 square feet of floor space, besides consuming the entire output of two additional foundries.

We agree with the man who said "Concrete is King." We see evidences every day of something new in the concrete line. Concrete machines and moulds must be made by some concern—why not by one which is peculiarly and particularly prepared to turn out such work in large quantities and at a minimum cost.



Plant of the Northwestern Steel and Iron Works Eau Claire, Wis.

SILICATE BRICK & STONE: "DIVISION METHOD."

The manufacture of silicate building material—brick and stone—out of sand and a small percentage of lime, has made such remarkable progress within the past few years, that the ambitious name "Building Material of the XXth Century," which has often been applied to this product, seems to be in a fair way to justify itself.

The International Sand-Lime Brick & Machinery Company have erected a number of plants for the manufacture of these products in the United States, of which those located at Washington, D. C., and Portage, Wis., are considered model factories in every respect, the buildings being of fireproof steel construction, throughout and the machinery of the most modern and approved type. The factory at Washington is equipped with direct connected electric motors, which renders it unique among brick-making plants.

The process owned by the International Sand-Lime Brick & Machinery Co., and employed exclusively in their own factories, is known as the "Division Method." Briefly this process is as follows:—

A portion of the sand—usually the smaller portion—in its naturally moist condition, is ground together with all of the lime (about 5% of the total material) into an impalpable powder of the fineness of cement. During this grinding in the presence of moisture the lime is partially hydrated and forms, with the sand, a perfect hydro-calcium-silica cement. This cement is then thoroughly mixed with the remaining portion of the sand and the mixture allowed to stand over night in a Silo or storage bin, in order to insure perfect hydration of the lime. From the Silo the material feeds by gravity directly to the Press where it is moulded into brick, under a tremendous pressure, at the rate of 36 per minute. As the bricks come from the Press they are stacked upon flat-top steel cars and run into a steel Cylinder 6 ft. in diameter by 72 ft. long, which will hold 20,000 bricks, the daily output of a single Press. At night the removable head is bolted on and the brick subjected to the action of steam under pressure of 120 pounds to the sq. in. for a period of 8 to 10 hours. The next morning the cars are drawn out of the Cylinder, and as soon as cool enough to handle, the bricks are ready for the wall.

The particular advantages claimed for the "Division Method" are that:

1. A very high grade brick is produced at
2. A very low price.

And judging from the practical results, as shown in the factories operating under this process, the claims are fully borne out by the facts.

CEMENT PIPE FOR SEWER PURPOSES.

By O. U. Miracle, Minneapolis.

No more convincing evidence of the fact that cement pipe is rapidly replacing salt glazed, vitrified and ordinary burned clay pipe for sewer, drainage and other purposes can be furnished than the literature detrimental to cement now being circulated by the industrious manufacturers of clay products and their association. At some points they concede everything above 20 inches in diameter to cement, and everywhere are making a hard fight to hold their own against this formidable competitor—cement.

It is an old saying that "competition is the life of trade," and in this case it could not be more forcibly illustrated, and it is certainly up to us now, as never before, as manufacturers of concrete goods, to turn out a product that is in every way worthy of the confidence of the public and even better than the best claims we have made for our products. This form of competition should put us on our mettle as never before.

For over twenty years cement pipe has been in general use in a few cities in this country, and especially in Milwaukee and Brooklyn, where it has given the very best of satisfaction. Fifteen or twenty years ago attempts were made to make cement sewer pipe in a number of cities throughout the country by using natural or hydraulic cement. Among those cities using pipe made of natural cement were Duluth, Minneapolis, Atlanta and a few other smaller cities. A good many failures are recorded of this, as the natural cement would deteriorate and give way, except in cases where it was given special treatment by curing in a tight chamber with steam and gas.

About five years ago manufacturers of pipe molds started a campaign of general publicity for cement pipe. It was met with derision by the clay pipe trust, and the failures, above referred to, of natural cement

pipe were cited as glaring examples of what would happen if cement pipe were again put into general use.

This campaign was vigorously pushed, and the results to date are most highly gratifying. Numerous smaller cities adopted cement pipe at once. Within the past few months a number of our larger American cities have also included in their specifications the use of cement pipe. Where bids are now taken for sewers, these are invariably for both cement and clay pipe. The specifications adopted are very rigid and call for a high class of pipe, properly made. But by the use of plenty of cement and carefully selected aggregate, a product can be turned out to meet these requirements with all reasonable business certainty.

In the early stages of the business the makers of cement pipe had many lessons to learn in order to make a product equal to all the exacting requirements to meet all conditions. But the American cement worker has proven himself an apt pupil, and has risen to the occasion. He is today turning out cement pipe that is in every way equal to and in many ways superior to the vitrified product.

The principal objection raised by the manufacturers of vitrified clay pipe to cement pipe was the contention that it would not withstand the action of sewer gases and acids. In a recent investigation conducted by the mayor of Kansas City these so-called objections were found to be groundless, and our opinion of five years ago of the durability of cement pipe is confirmed by the following extracts of letters addressed to the mayor of Kansas City by some of the most reputable engineers.

Furthermore, the common experience of even the most casual observer sets the whole objection at naught. The sewers using vitrified clay pipe or brick in every case use concrete for the joints, which shows that the men who raised the objection are either not sincere or not observant of this universal practice.

Another objection made by the advocates of clay pipe was that cement sewers were not strong enough. This objection was mostly easily eliminated, as hundreds of tests have been made, all of them showing that a reasonably well-seasoned cement pipe is much stronger than one of clay.

In a recent visit to Memphis, Tennessee, the writer had the pleasure of visiting the plant of A. L. De Shazo, of that city, who started in a small way two or three years ago to make a few sizes of cement pipe.

During the year 1909 his sales of cement pipe exceeded \$15,000, and at prices practically the same as those received for vitrified pipe of similar sizes. This manufacturer is making cement pipe up to 36 inches in diameter, and the volume of business referred to has been done entirely outside of the city of Memphis, all of his stock being sold to county and township boards for use in culverts and other purposes where pipe is required.

Mr. De Shazo submitted a specimen of pipe from his regular stock at a prize contest at the Cement Products Exhibition in Chicago, February, 1909, and was awarded first prize, the judges commenting especially on the compact and even texture of his pipe. It showed very careful curing and thorough tamping, their only criticism being on the selection of aggregate, as it was found that this specimen could still have been improved by using coarser materials.

Mr. De Shazo, heeding the criticism of these judges, has been more careful in the selection of his material, using a good percentage of pea gravel, and the product he has been turning out is of the very best. He now uses a mixture of one part of cement to three

parts of sand and gravel, being composed of equal parts fine to medium sand and pea gravel, thoroughly tamped and made just as wet as it can be so that the pipe will stand alone when the molds are removed.

The city of Denver recently awarded its first large contract for cement sewer pipe. The amount of the contract is about \$66,000. Bids were solicited on both cement and clay pipe. It was found that in most sizes of pipe cement could be laid in the ditch cheaper than vitrified clay pipe could be laid on the bank of the ditch.

In the field of drainage hundreds of miles of cement pipe have been used in the past three years. Throughout the country plants are springing up and thousands of men are engaged in producing cement tile. The period of experimentation in cement pipe for various uses is past. There are still critics, but the man who goes into the business to make an honest product need have no fear of his success. The history of over 90 per cent. of the plants that have been started has been that they have been unable to take care of the business as fast as it has been offered, and very generally at a handsome profit.

WATER PURIFICATION.

The Wm. B. Scaife & Sons Co., of Pittsburg, Pa., have issued an illustrated treatise on the above subject which sets forth in a lucid manner the dangers to which boiler plants are constantly exposed by

send for this pamphlet and feel confident they will find in it a great deal of additional information.

The Wm. B. Scaife & Sons Co., are the oldest manufacturers of Water Softening and Purifying Systems in this country. Their publications are well-known; some of them go under the name of J. C. W. Greth, who is the manager of the Water Purifying Department of the firm. We mention, for instance, "Water for Economical Steam Generation" and "Scaling and Corroding Substances and Their Elimination from Water for Boilers." These give in plain figures the saving resulting from water purifying plants and represent at the same time exhaustive and interesting literature on the subject.

A great many of the cement mills throughout the country are equipped with the WE-FU-GO Water Softening and Purifying System manufactured by Wm. B. Scaife & Sons Company.

AUTOMATIC SCALES DUMPED BY CLOCK WORK.

Automatic scales operated electrically by clock-work are used at the new coagulant plant of the St. Louis Water Works, to weigh and discharge periodically proper amounts of lime from a large overhead supply tank into lime-slaking tanks below. In a paper read at a recent meeting of the Engineers' Club of St. Louis, Mr. Arthur I. Jacobs, engineer in charge of the water supply and purifying division,



We-Fu Go Water Softening and Purifying System, Manufactured by the Wm. B. Scaife & Sons Co., Pittsburg, Pa.

scales forming in the tubes or flues, and which, furthermore, explains the most efficient methods of remedying damages of this nature and of giving boilers the proper care by the installation of a water purifying plant and by thus feeding into the boilers only water free of scale-forming elements.

This publication is well worth studying and will be welcomed by every engineer or factory owner who takes pride in the smooth and economical operation of his boiler plant and engine room. Although most engineers in charge of boilers may believe to know enough about water-purification, we advise them to

stated that when the weighing bucket is filled with its proper weight of lime and the admission gate from the supply tank above it closed, a rod connected to the discharge gate of the bucket is held fixed by a system of levers arranged as a toggle with its three points in line, so that material is prevented from flowing out. The plunger of a solenoid, energized through a relay operated by a clock at the proper time, breaks the three-point alignment, opens the discharge gate, and permits the scales to dump. The current for the solenoid is obtained from one of a duplicate set of motor-generators of 450-watt capacity; one of the

motors takes current from a 500-volt, direct-current line and the other from a 110-volt, alternating-current line. Both generators deliver 30-volt direct current. The scales weigh material in quantities from 40 to 100 lb. by $\frac{1}{4}$ -lb. increments and may be dumped once in one, two, or four minutes. With this combination of weights and time intervals, Mr. Jacobs states, any weight between 10 and 100 lb. per minute may be discharged from the supply tank into the lime-slaking tanks. The equipment was furnished by the Richardson Scale Company of New York.

CEMENT MILL NEWS.

The Marengo Portland cement plant at Caledonia, N. Y., the principal industry of this place, which has been closed down since December 1st, will re-open in a few weeks when the repairs now in progress are completed. New officers have been selected. They are: President, E. L. Buell, of Detroit, Mich.; vice-president, M. D. Kleinzahler, of Youngstown, O.; secretary and treasurer, S. A. Ford, of Cleveland, Ohio. The head offices will be removed to Detroit.

* * *

Bags in which cement is brought to the Isthmus are carefully preserved, baled, and returned to the United States, where the cement manufacturer gives a rebate to the Commission of $8\frac{1}{2}$ cents each. Up to Nov. 20 there had been brought to the Isthmus under the new contract for cement 335,988 bags and 145,540 barrels of cement. The barrels are destroyed. On Nov. 20, there had been shipped to the States 102,357 bags, and 174,680 were ready for shipment.

* * *

Philadelphia, Pa.—Another step in the investigation of the alleged cement freight rate discrimination by railroads against this port was taken yesterday, when William B. Irvine, chairman of the Joint Cement Committee, and president of the Knickerbocker Lime Company, announced that the report of William A.

was investigating the charges that the coal-carrying railroads were discriminating in favor of certain dealers. His report shows that the Pennsylvania and Reading Railroads are not justified in charging a rate to this port of \$1.25, while giving New York the advantage of a rate of 80 cents. The haul to this port is 21 miles shorter than to New York.

An effort will now be made to induce the railroads to grant a rate to this city of \$1.10. If this attempt fails the report of Mr. Glasgow will be submitted to the Interstate Commission with a request that it make an investigation of the abuse and force the roads to correct the injustice.

* * *

The sale of the Art Portland Cement Company plant at Kimmell, organized about six weeks ago in Noble county to make cement from the marl deposits around Lake Wawasee, was held recently at the Provident Trust Company in Ligonier, Ind.

The trust company was appointed receiver for the plant some time ago, and Manager M. L. Galbraith, of the company, conducted the negotiations that ultimately closed the business of the concern for the time being.

William Fortune, of Indianapolis, a member of the original company, and representing the first mortgage bond holders, bid off the property at a total of \$40,869.99. The first mortgage bonds amounted to \$36,024.55, and with expenses and fee allowances of \$4,872 swelled the total to the amount named. It was bid in for the amount named.

* * *

Victor Beutner, a prominent Pittsburg engineer, who built the Altoona Portland Cement Co.'s plant, is building the Lumberman's plant at Carlyle, Kan. They are putting in thirty-two Maxecon mills, using them both on the raw side and the clinker.

* * *

William P. Dickinson, father of Theodore G. and William Dickinson, vice-president and general man-



We-Fu-Go, 6,000 H. P. Water Softening and Purifying Systems Installed at the Hannibal Plant of the Atlas Portland Cement Co., by the Wm. B. Scaife & Sons., Pittsburg, Pa.

Glasgow, Jr., counsel for the committee, upheld the contention of the protestors that the railroads were dealing unjustly with Philadelphia in the matter of rates.

Mr. Glasgow formerly acted as special counsel for the Interstate Commerce Commission when that body

ager, respectively, of the Marquette Cement Manufacturing Co., died suddenly January 30. Despite his advanced years—his age was 89—Mr. Dickinson's death was unexpected, as he was a man of robust health, and active in business affairs up to the very last. Born at Hadley, Mass., in 1820. Mr. Dickinson

came to Chicago in 1860, and became an influential factor in the commercial life of the city, especially in connection with the Board of Trade. He leaves a widow, three sons and one daughter.

* * *

Mr. C. J. Van Doren, recently superintendent for the Ash Grove Portland Cement Company, is now manager for the Altoona company in place of Victor Beutner.

* * *

Mr. S. K. Simon has resigned his position with the Northwestern States Portland Cement Company to become chemist for the Southwestern Portland Cement Company.

* * *

Judge John C. Pollock of the federal court in Kansas City, Kan., has approved the contract recently entered into by the Bonner Portland Cement Company with the Lumberman's Portland Cement Company of Kansas City, Mo., whereby the latter company agrees to purchase the output of the Bonner company for the ensuing year. The bond of \$15,000 for the fulfillment of the contract was also approved by Judge Pollock.

Permission was obtained from Judge Pollock a few weeks ago to operate the plant for a reasonable length of time in order to determine whether it could be run on a paying basis. This fact has been demonstrated by the contract just entered into, which calls for the total yearly output of the plant, averaging 30,000 barrels a month.

* * *

During the past month a force of eighty men have been at the cement plant of the New Aetna Portland Cement company, Fenton, Mich., making the necessary repairs prior to the run for 1910 and everything will be in readiness to begin operations by March first.

Everything points to a successful year for the mill and the opening will mean much to the laborers of Fenton. E. M. Bunce formerly with Dewey Portland Cement Co., is superintendent.

SILICATE BRICK NEWS.

Janesville (Wis.) Granite Brick & Stone Co., is to remove to Oklahoma City, and double capacity of plant.

It is reported that within the next five or six months the International Sand, Lime, Brick & Machinery Co. will erect three complete factories in the states of Texas, Georgia, and on Long Island, N. Y.

Excelsior Granite Brick Co., of Chicago, Ill., are increasing capacity of plant at Michigan City, Ind., from 17,000 to 35,000 per day.

Buffalo (N. Y.) Sandstone Brick Co. report trade conditions very promising, and 1910 is expected to be a banner year. During past year manufactured four times as many brick as in 1908, about 2,000,000 being sold in Buffalo alone.

The Florida Sandstone Brick Co., Jacksonville, Fla., has taken over the plant of the Florida White Pressed Brick Co., and purchased additional machinery and will build new buildings. John D. Baker is president of the company, which has \$30,000 capital.

The International Sand, Lime, Brick & Machinery

Co. are advertising a new automatic tamper for the production of silicate block and stone of any desired dimensions, which is claimed to be the most efficient and economical tamper on the market for either silicate or cement block products.

NEW CEMENT PLANTS TO BE BUILT.

Kingsport, Tenn.—The Clinchfield Portland Cement Company which has recently acquired considerable desirable quarry property near here, is now letting contracts for a modern cement plant. This is designed for a present capacity of 1,000 bbls. per day with an ultimate output of 3,000 bbls. It will be the first plant of its kind in this section to be equipped throughout with electric drive. The contracts for both power and cement machinery have been awarded to Allis-Chalmers Company and will include the following: Three rotary dryers 6 x 60 ft. two rotary kilns 8 x 125 ft, one No. 9 style "K" Gates crusher, one No. 9 style "B" Gates elevator, two 750 K. W., 440 volt, 60 cycle, 3 phase steam turbo generator with separate Tomlinson condensers for each, one 35 K. W. motor generator exciter and one 35 K. W. steam driven exciter, one 200 H. P., one 75 H. P., seven 60 H. P., two 30 H. P. and three 20 H. P. induction motors will drive the various apparatus.

* * *

Raven Lake, Ont., Can.—The Kirkfield Portland Cement Company is largely increasing the capacity of its plant here and has recently awarded a contract to Allis-Chalmers Company for an 8 x 125 ft. rotary kiln.

* * *

Pittsburg, Pa.—The Castalia Portland Cement Company of Pittsburg, Pa., has decided to increase the capacity of its plant one-third and will spend \$50,000 in the work. Improvements in the wet and dry grinding department, additional machinery and the enlargement of the plant is part of the improvement. The work is expected to be completed by spring and will make the total annual capacity of the plant between 500,000 and 600,000 barrels of cement. Their plant is located at Castalia, Ohio.

* * *

P. A. Bernal, Eden Vale, Calif., has 200 acres of land in Santa Clara county, nine miles south of San Jose, which contains inexhaustible ingredients to make Portland cement. This land is for sale.

* * *

The Inland Portland Cement Company's new plant will be located on the plateau at the mouth of Sullivan creek, on the east shore of the Pend Oreille river, opposite the old town of Metaline, says the Spokane Daily Review. This will also be the present terminus of the I. & W. N., a new road recently built. The new plant will cost \$1,000,000 and will have an output of 2,000 barrels of cement daily. So advantageously has nature placed the deposits of lime and clay, it will be possible to manufacture the cement at an exceedingly low cost, experts say.

The principal clay deposit rises in a bluff 500 feet high, directly south of the location of the cement plant. This cliff extends a mile and a half up Sullivan creek. The lime deposit is located on a still higher bench to the south and from a small hill 300 feet in height by 1,200 feet in breadth, continues on still further south into practically a mountain. Both the clay and lime can be carried to the cement plant by gravity at low cost, on cable tramways.

The Inland Portland Cement Company will manufacture its own brick for building its power house and

cement factory. A brick kiln will be started as soon as the weather permits. The ground is already prepared for the foundations. The plant will be erected under the supervision of F. C. Fisk of Pennsylvania, a cement expert. In speaking of the new enterprise Mr. Fisk said:

"Our deposits of lime, clay and shale are practically inexhaustible and, together with our cheap electric power, are so located that we will be able to manufacture the cement at the lowest possible cost. We will be able to market the product throughout the Inland Empire and even to meet competition at Coast points and many eastern points. Our factory will be one of the best equipped in the country and will have a daily capacity of 2,000 barrels. Besides the I. & W. N. interests, one of the largest cement manufacturers in the east is back of the enterprise.

* * *

The Nebraska Portland Cement Company is the latest industry to be launched. Headquarters will be in Omaha, the testing laboratories in Kansas City, Mo., and the works at Superior, Neb., where the company owns 320 acres of land, all of which is underlaid by deep beds of the richest cement materials. In addition, the company owns a large tract of cement land, a plant and extensive buildings at Milford, Kans., a few miles south of here. This is in the heart of the rich cement and limestone deposits of the Republican river valley.

* * *

Concrete, Colo.—The United States Portland Cement Company is improving its plant here by the addition of new machinery. It has awarded a contract to Allis-Chalmers Company for a rotary kiln 8 x 125 ft. complete with stack and feeder.

CANADIAN CEMENT SHOW.

Officers of the Canadian Cement and Concrete Association are making great arrangements for their second annual cement show which is to be held at Princess Rink, London, Ontario, March 29-30-31 and April 1. Manager A. M. Hunt, who is the director-general of the big show, is already receiving entries at a rate which makes it certain that the exhibition will be a whopper. Many prominent American firms will be represented, the matter of duties on goods shipped here for exhibition purposes only having been satisfactorily taken care of. Goods under \$100 in value will be admitted, and may be shipped back without intervention by the customs authorities. In instances where the goods are worth more than \$100, a certificate must be obtained from a U. S. consul at the border. With this, and a duplicate invoice for the consul's inspection, the exhibitor will have no trouble with the customs officials.

The first allotment of space will be made February 28. This allotment will be made by a drawing of exhibitors' names, the first one out of the box to have first choice of space, etc. After this, if there is any space left, it will be assigned in the order of application.

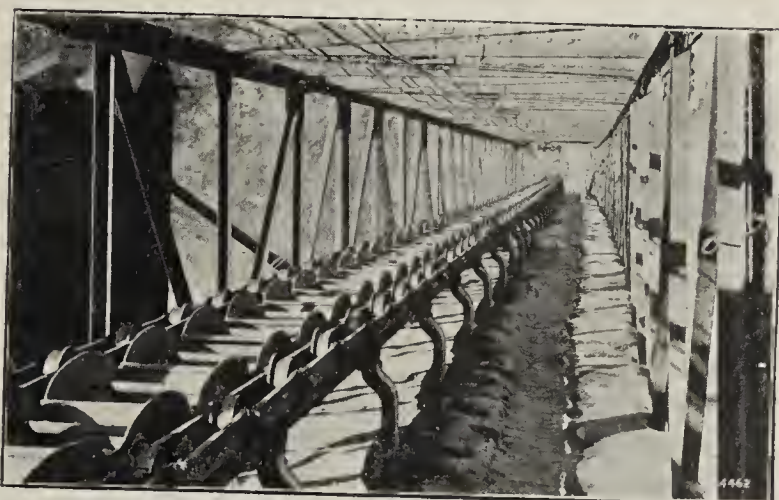
Goods for exhibit, freight prepaid, may be consigned to the management and will be cared for, without responsibility on the part of the management for loss of any kind.

There are only 63 spaces provided for, and it is almost a certainty that there will be more applicants than can be accommodated. The show was a big success last year. It bids fair to be a still bigger one this year.

PECK CARRIER

THE STANDARD MACHINE
FOR HANDLING

Cement, Crushed Rock,
Hot and Cold Clinker,
Coal. Etc.



PECK CARRIER For Cement.

Union Portland Cement Co., Devil's Slide, Utah.

Full particulars of the Carrier's Construction, by which horizontal conveying position is assumed and resumed without the necessity of overturning the buckets, will be explained in detail, and your name put on our list for a copy of the book now in press, if you write to us.

LINK-BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

NEW YORK,
299 Broadway.

PITTSBURGH,
1501-2 Park Bldg.

ST. LOUIS,
Missouri Trust Bldg.

SEATTLE,
439-440 New York Block

DENVER,
Lindrooth, Shubart & Co.

NEW ORLEANS—Wilmot Machinery Co.

GLIDDEN

GLIDDEN'S LIQUID CEMENT

Uniforms the color of Concrete-Cement and Plaster surfaces, producing a waterproof result.

Made in Sandstone finish and several shades along the lines of Colonial and Pompeian Buffs.

Inexpensive and easily applied.

Samples and full information gratis upon request.

A product of The Glidden Varnish Company, exclusively.

The Glidden Varnish Company, CLEVELAND
OHIO

GLIDDEN



JEFFREY STORAGE BATTERY TRUCK

Reduces the cost and greatly facilitates the handling of materials around Cement Plants, Mills, Etc.

It is designed for use on any gauge track from 18 inches up.

The electrical equipment is furnished in sizes to suit the service. Around the average manufacturing plant a 6 h. p. equipment will operate 2 or 3 days on a charge.

Let us know the approximate weight loads and length of your haul and we will determine a suitable equipment.

Elevating and Conveying Systems, Screens, Crushers, Drills, Excavating and Screening Plants, Concrete Mixers, etc. SEND FOR CATALOG Aa 81

THE JEFFREY MFG. CO., Columbus, Ohio.

Limestone and Shale

FOR MANUFACTURE OF

Portland Cement

ON THE

Illinois Central Railroad

IN THE

West and South

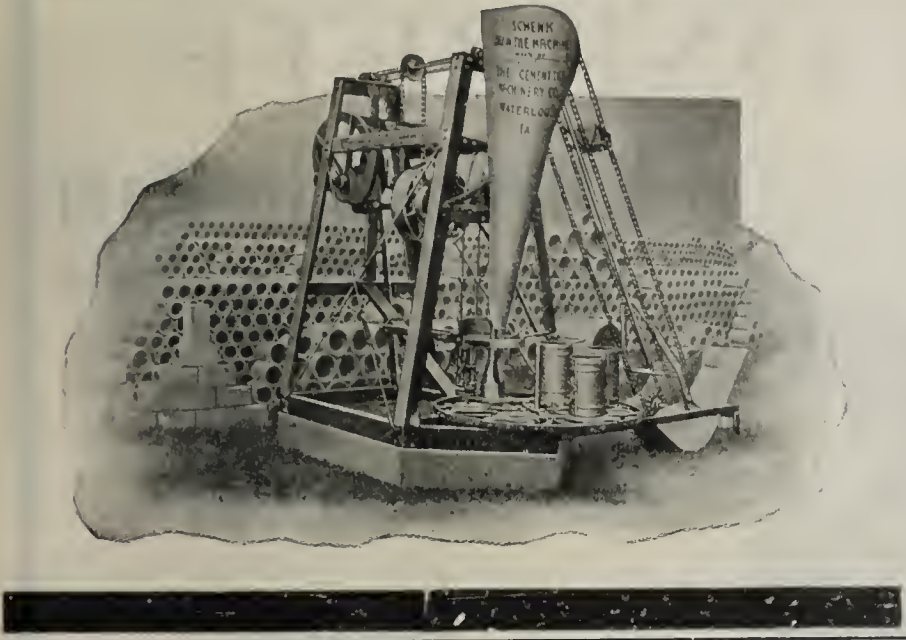
Coal, Water and Good Labor

For Full Particulars Address

J. C. CLAIR,

Industrial Commissioner, I. C. R. R. Co.

1 Park Row - Chicago



Would You Reduce the Price?

If you had originated the idea of manufacturing cement tile by machinery, placed the first machine on the market and fostered it to success; if you knew your machinery to be the most efficient, the most popular equipment, and considered the only proven success, would you reduce the price?

No, we think you would not. But here is the point: The time has come when there must be a greater distribution of tile factories—the trade demands it. We have grown from a small start in the machinery business to the largest exclusive concrete machinery manufacturers in the world. We have a plant capable of turning out in the year 1910 two hundred Schenk machines, and we figure if we can manufacture and sell this number we can afford to reduce the price. Thus you get the benefit of our almost phenomenal success, for every community is offering an opportunity for the manufacture of this product and you are now able to get into the business with but a comparatively small investment.

Get Our Catalog

In this advertisement, space is too limited to explain fully the details of our new selling plan, and in order that you may better appreciate the facts about the business and the real merits of the Schenk Machine we have published a little booklet, "Money in Cement Tile," which will be sent to you absolutely free. Just fill out the coupon below.

THE CEMENT TILE MACHINERY CO. WATERLOO, IOWA

FREE INFORMATION COUPON

I am interested in the manufacture of cement drain tile. Kindly mail me complete information regarding your 1910 proposition, also copy of "Money in Cement Tile."

Address

Name

Town

State

C. & E. N.-2-10



CONCRETE CULVERTS

will soon replace all other kinds of Culverts, because they are comparatively cheap and practically indestructible, while other Culverts are but temporary and must soon be replaced.

The Merrillat System

of building concrete Culverts is the cheapest and most satisfactory.

The Merrillat Adjustable Core

is not only collapsible like other Culvert forms, but is adjustable to positively any size between 20 and 48 inches. It is entirely automatic and at any size is braced, locked and round.

This means one form and therefore one investment for all your Culvert work. Why buy a form that makes but one size, when ours which makes every size costs no more?

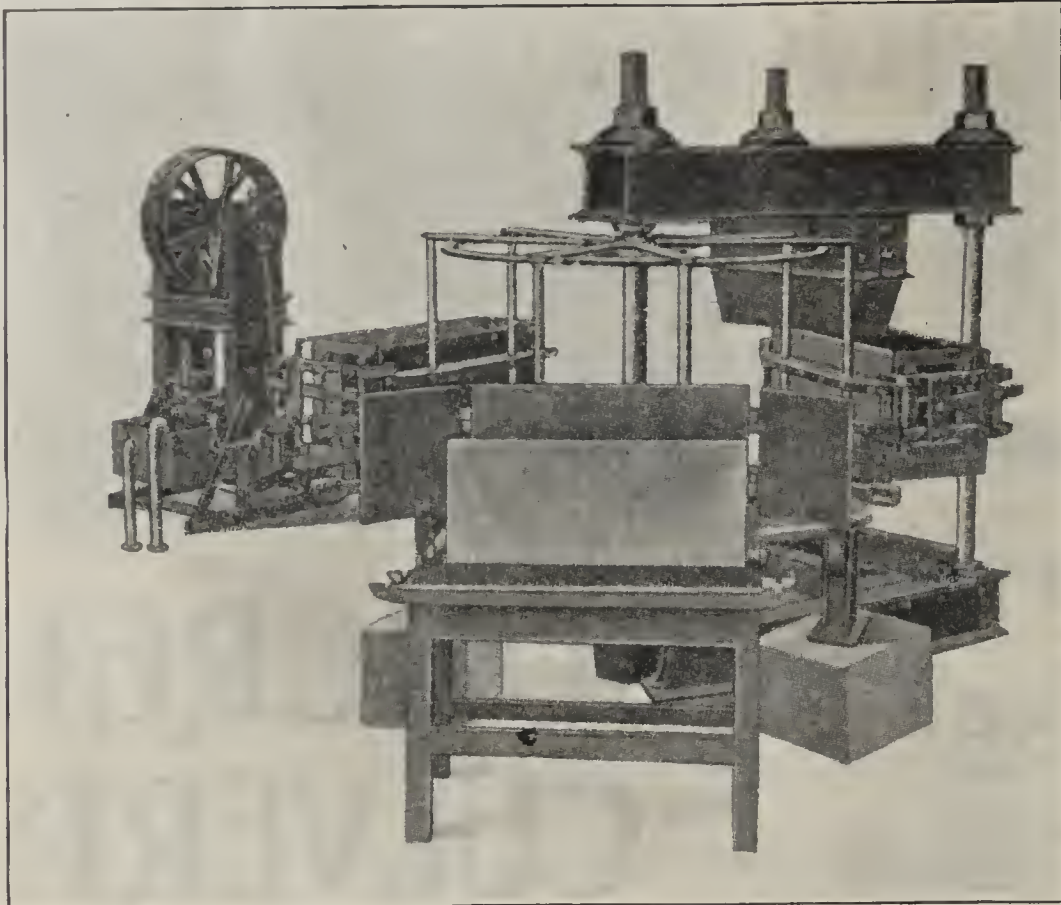
GET OUR CATALOG

The Merrillat Culvert Core Co.

400 RAILROAD STREET

WINFIELD, IOWA

A DENSE CONCRETE



A Hydraulic Ram Pounding Concrete Into Blocks

TWO MEN do the work. From 1000 to 2000 blocks per day. Three quick-acting mold boxes rotating over the Ram on a Revolving Table, one being filled, one receiving the pounding, one delivering the finished block.

The Fisher Hydraulic Machine pounds a wet mixed mortar together with a Hydraulic Ram and produces a dense concrete with less than 5% absorption, with a high crushing strength, in any style to suit the demand.

Ask for Catalogue or any information regarding our system.

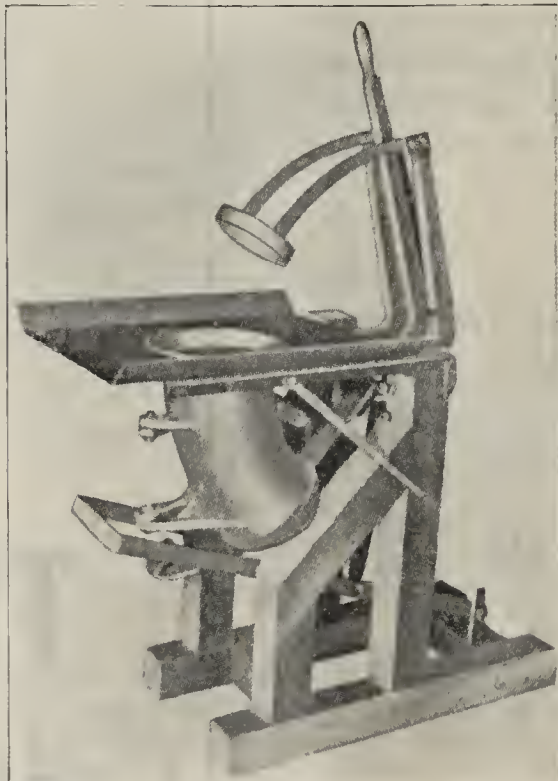
Fisher Hydraulic Stone & Machinery Co.

Builders' Exchange Building, Baltimore, Md.

Concrete Sewer Pipe Bends

The Only Machine
of Its Kind
on the Market.

Concrete Sewer Pipe
Bends Made on the
**RICKMAN SEWER PIPE
BEND MACHINE** Make
Money for the Manu-
facturer.



The Latest Thing
Added to the Concrete
Machinery Line.

ONE MAN can make from 15 to 20 curved sections of pipe per hour. Shovel in the material, tamp it with the tamping ring, operated by foot lever, attach the bell-end form, complete the section, withdraw core from below, by lever, carry the pipe away to a pallet and bring the outer mold back to the machine.

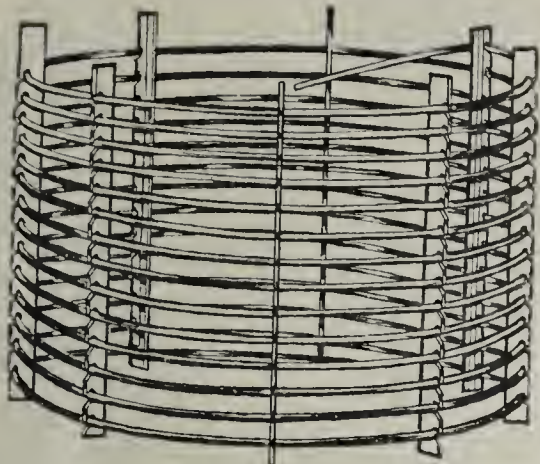
You Need This Machine to Complete the Equipment of Your Tile Factory

Write for Circulars and Prices

R. L. RICKMAN CO., 987 Westminster Avenue,
VANCOUVER, B. C.

Steel Reinforcing Department

If you have contracts for reinforced concrete work—or are only figuring on it—you will find our Steel Reinforcing Department of great assistance to you. Our method of making a lump sum bid on all the reinforcing material required for



Our Built-up Spiral Column Reinforcement can be quickly furnished to meet your requirements

a job will interest you. We save you time in estimating and make you a price you can rely on. It will frequently be to your advantage to have us bend your bars to the shapes required in your work.

Get our unit prices on Bars, Expanded Metal, Wire Mesh, Metal Lath or send us your plans and let us make you a lump sum bid on your entire



Standard Size Sheets, any gauge or quantity, can be shipped from our Chicago stock

requirements. Prompt shipment from our mills or immediate shipment from our Chicago stock can be made on our M/B Cold Twisted Bars, Plain Round or Square Bars, Expanded Metal, Wire Mesh or Metal Lath for reinforced concrete construction.

M/B *Special* Open Hearth Bar (Cold Twisted) FOR REINFORCING CONCRETE

is a superior steel manufactured under most rigid specifications. It is the only known steel which has ductility and high elastic limit combined. Costs no more than ordinary deformed steel and guarantees the safety of your concrete.



M/B Bar, elastic limit, 64,000 lbs. per square inch. Specimen was bent cold

The M/B Bar—"The Bar that Never Failed"—is rolled from new billet stock. Its elastic limit is approximately 60,000 lbs. per square inch, yet it is not brittle—for it can be bent double cold without fracture. This feature means a saving of several dollars a ton in handling and bending alone. Shown by United States Government tests to have highest mechanical bond.

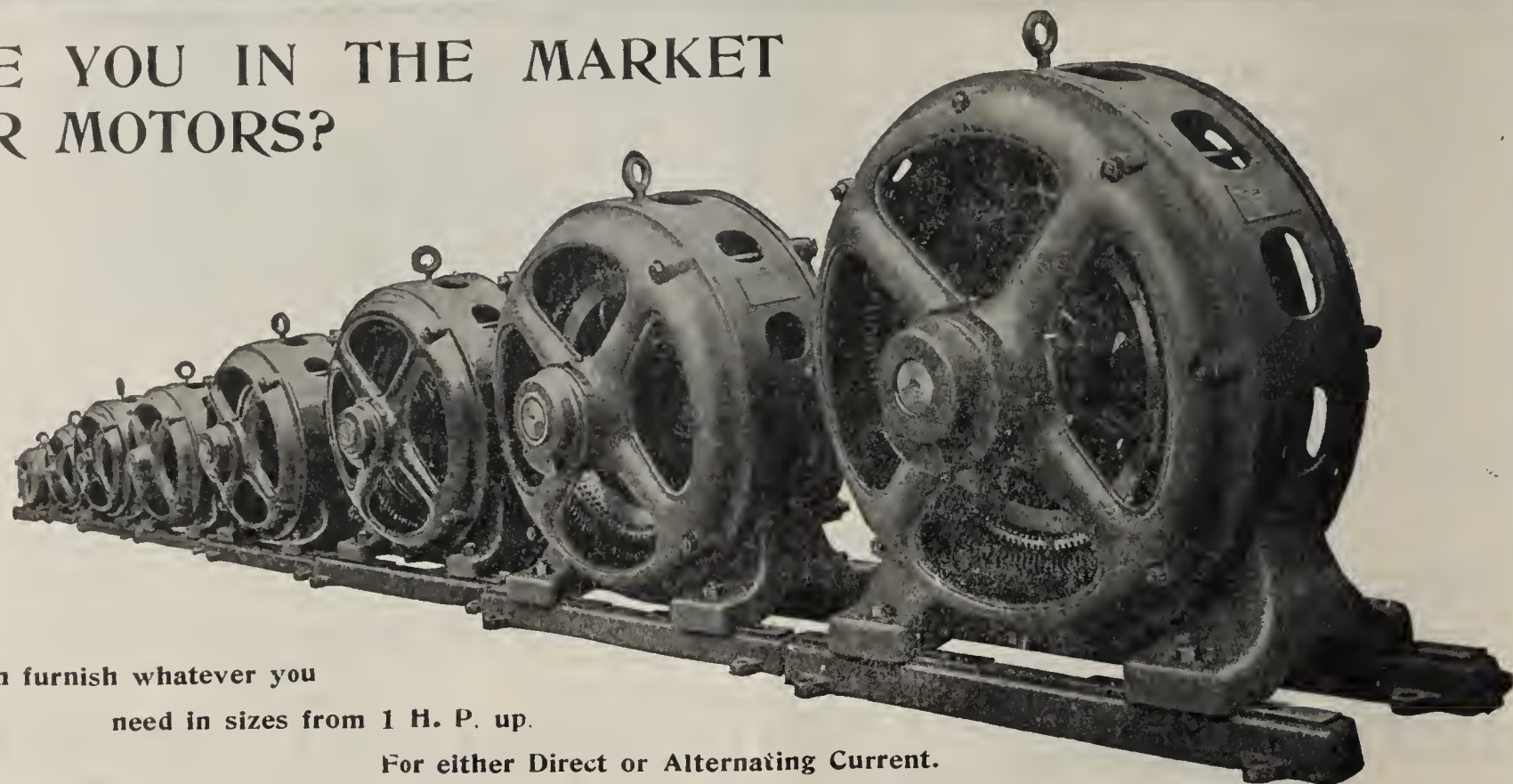
WILLIAM B. HOUGH COMPANY

"Where the best Reinforcing Steel comes from"

C H I C A G O :: U. S. A.

ALLIS-CHALMERS CO

ARE YOU IN THE MARKET
FOR MOTORS?



We can furnish whatever you

need in sizes from 1 H. P. up.

For either Direct or Alternating Current.

ALSO

CEMENT MAKING MACHINERY

for every stage by either Wet or Dry Process

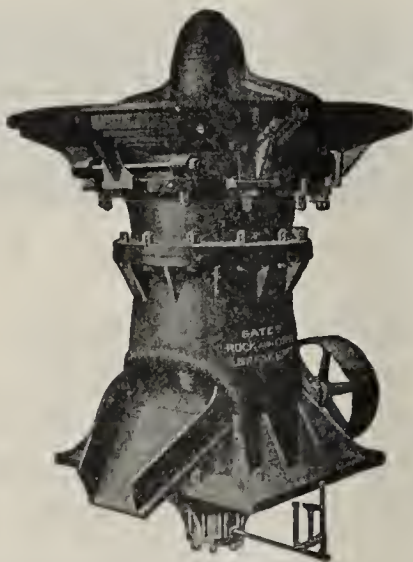
Rock Breakers
Crushers
Dryers

Elevators
Conveyors
Mixers

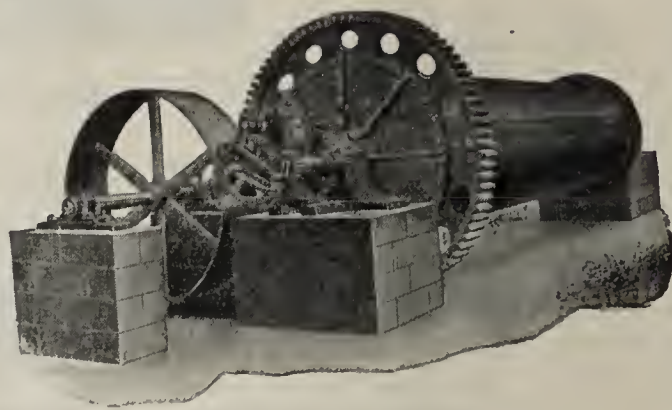
Ball Mills
Tube Mills
Kilns



Ball Mill with Feeder Attached



Style "K" Breaker



Tube Mill

Power and Electrical Machinery of Every Description, Air Compressors

Revolving and Stationary Screens, Perforated Metal of All Kinds, Feeders, Belt Elevators, Belt Conveyors,
Friction Hoists, Electric Hoists, Dump Cars

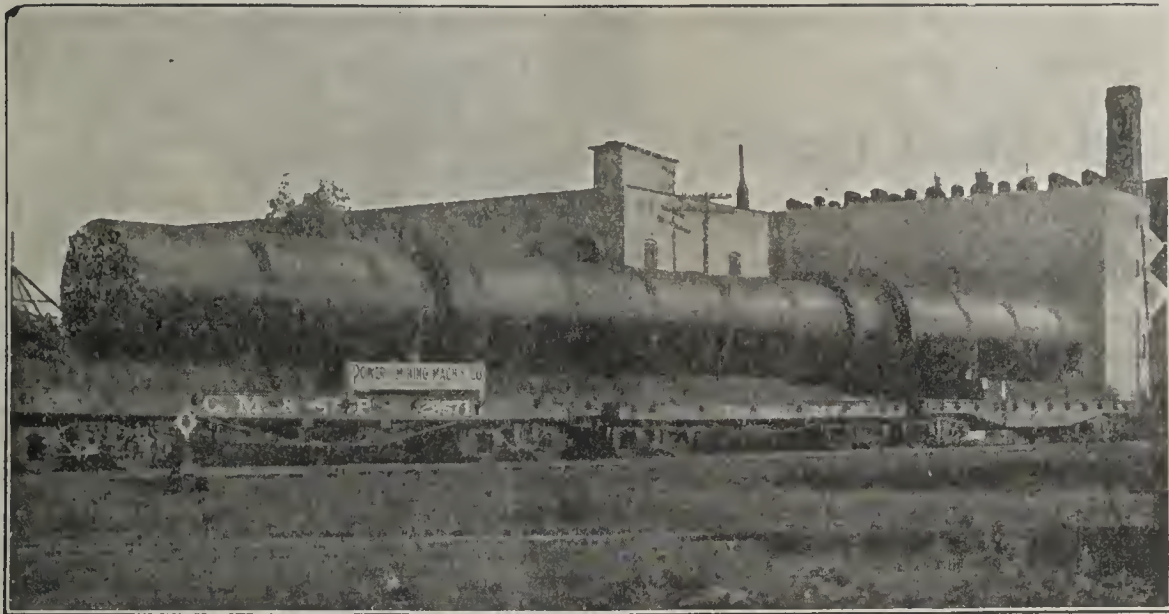
WRITE FOR DESCRIPTIVE BULLETIN

General Offices: Milwaukee, Wis., U. S. A.

Cement Mill Machinery

A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process.

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



Write for Catalogue No. 17.

Power & Mining Machinery Company

MILWAUKEE, WIS., U. S. A.

CHICAGO.

NEW YORK.

ATLANTA.

EL PASO.

SAN FRANCISCO.

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

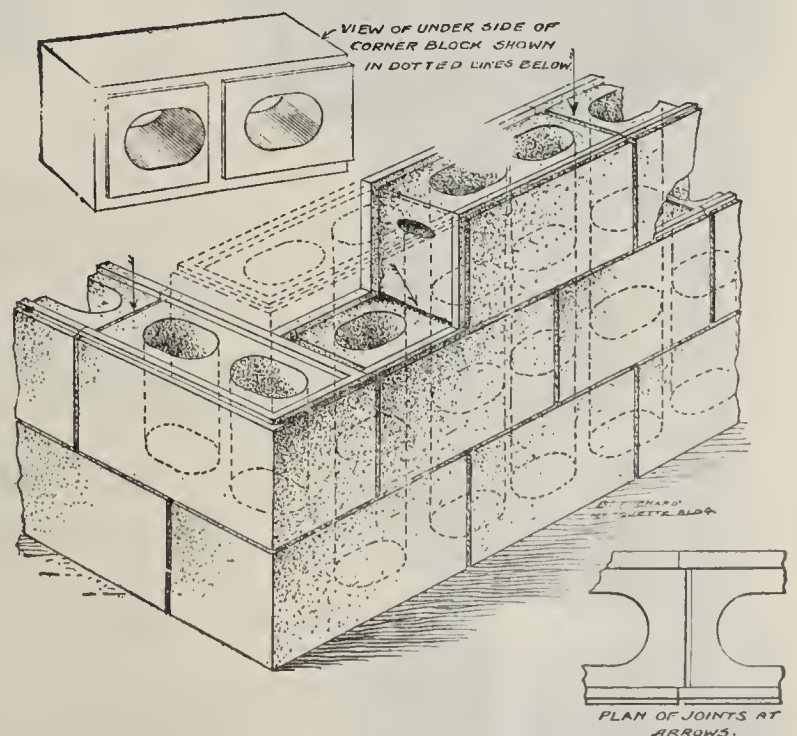
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting Face-Down Machine by the Wet Process

The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and agents wanted in all states and foreign countries.



DIAMOND CONCRETE MACHINERY COMPANY

Tacoma Building,

- - - - -

Chicago, Illinois

Adjustable Steel Centers

Makes Concrete Sewer and Culvert Work
Cheap, Easy and Very Profitable

No large amount of money is required
either to lease or buy. No high-priced
mechanics are needed where

Our Patented Steel Centers

are used. They will outlive you, and
require no repairs.

Telegram.

Ship today four five-foot sections of thirty-six inch culvert forms to
Morris, Illinois. Joliet, Ill., Sept. 19, 1908.
Joliet Steel Construction Co.

Their Second Telegraph Order.

Ship today two five-foot sections thirty-six inch forms to Des
Plaines, Illinois. Joliet, Ill., Oct. 14, 1908.
Joliet Steel Construction Co.

Their Third Telegram.

Ship to McNab, Illinois, at once, two Special Centers, six feet long,
four feet diameter, per yours even date. Joliet, Ill., Sept. 27, 1909.
Joliet Steel Construction Co.

Dealers and Other Representatives Wanted Everywhere.

Adjustable Steel Centering Co.

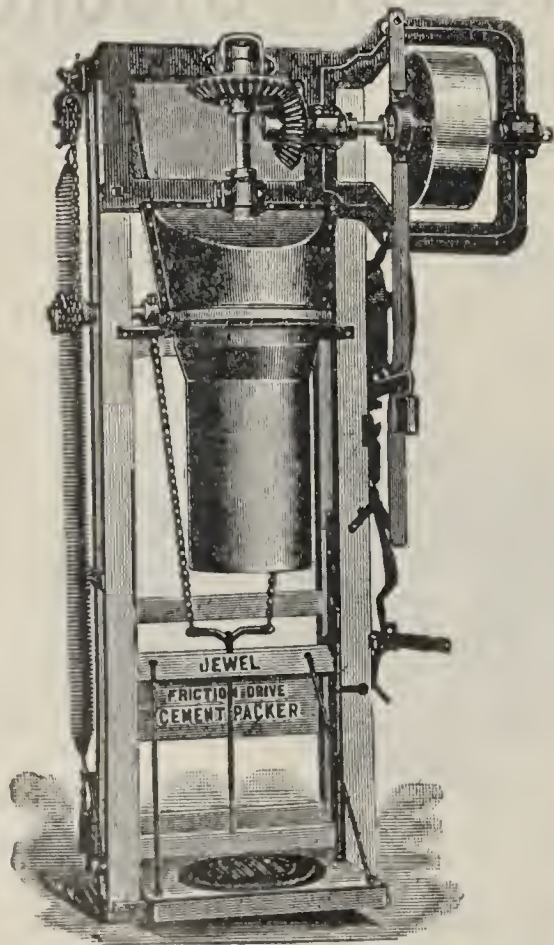
48 Forest Avenue, : : Fond du Lac, Wis.



Sixty-inch Reinforced Concrete Sewer, Appleton, Wis.
Chas. H. Vinal, Construction Engineer.

Notice skidway track in bottom—our Special Center—on which collapsed
six-foot rear full-circle sections are slid to the front by two
men for re-setting only as fast as needed.

There is more Cement being packed by the "S. HOWES" Company's
Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and
sacks.

The "JEWEL" FRICTION driven cement Packer, specially
constructed for rapidly packing sacks.

Both machines are equipped with friction pulleys, heavy iron
frames which carry all the working parts.

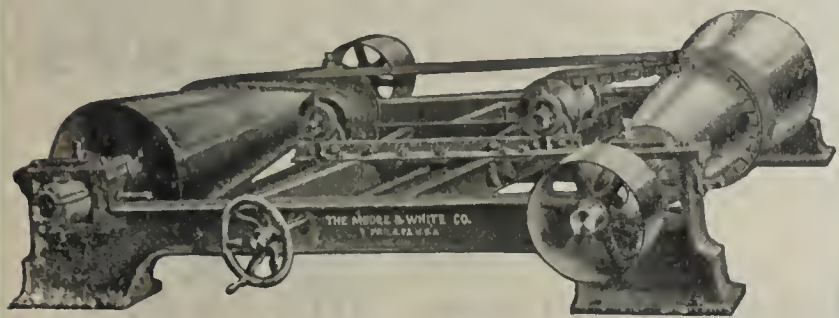
Are strong constructed throughout. Guaranteed fastest and most
durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company

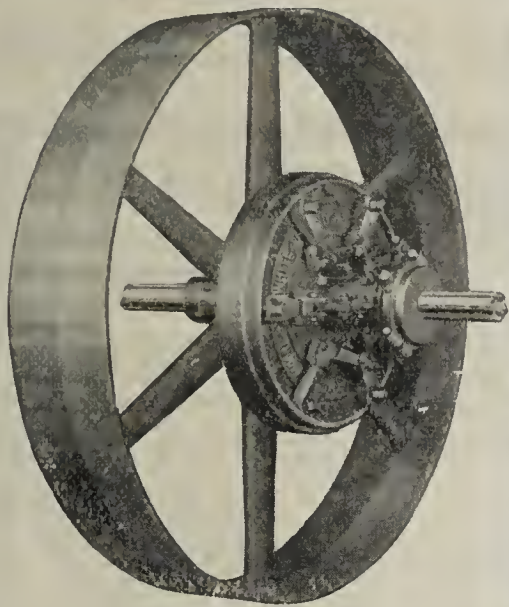
SILVER CREEK, N. Y.

It will be to any Mill Owner's advantage to investigate these two economical Power devices.



M. & W. Speed Change.

Power
Transmission
Machinery
for
Cement
Mills.



Friction Clutch Pulley.

Write for
Catalogue.

The Moore & White Co.,
Philadelphia, Pa.



Universal is Uniform

Uniform in soundness—
Uniform in strength—
Uniform in fineness—
Uniform in color—
Uniform in specific gravity—
Uniform in setting qualities—
Uniformity means superiority.

Use Universal—it produces uniformly excellent results.

Universal
Portland Cement Co.
Chicago — Pittsburg



DEXTER Portland Cement
THE NEW STANDARD

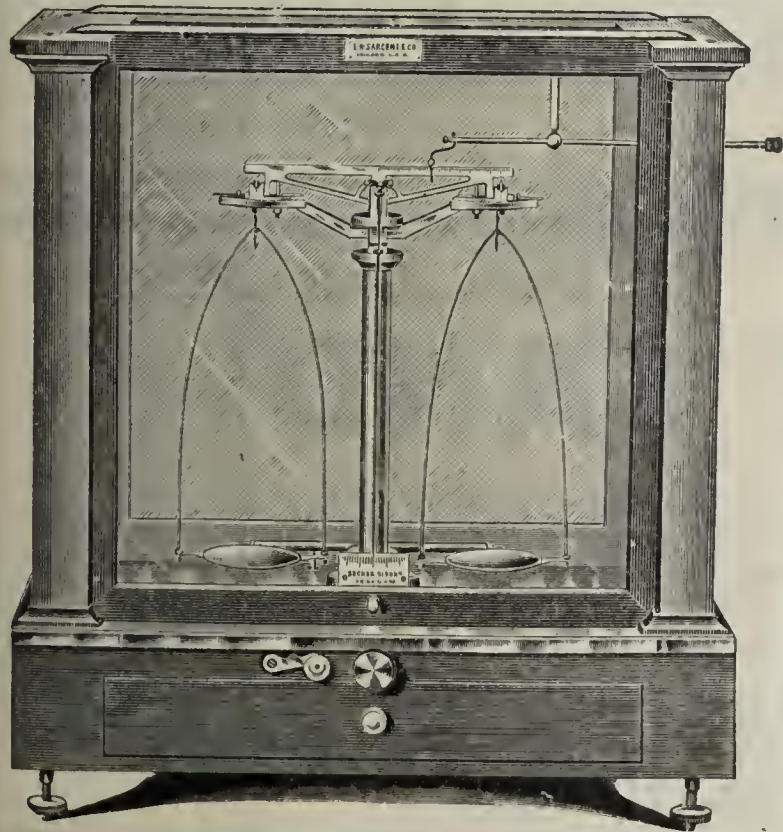
Sole Agents **SAMUEL H. FRENCH & CO.** Philadelphia



HAVE YOU AN IDEA?

If so write for our books: "Why Patents Pay," "What to Invent," "100 Mechanical Movements" and a Treatise on Perpetual Motion—50 illustrations. All mailed free.

F.G. DIETERICH & CO. Patent Lawyers and Experts
801 Ouray Block WASHINGTON, D.



E. H. SARGENT & CO.

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN

CHEMISTS SUPPLIES

Of high grade only.

We call particular attention to our Cement Mould, Vicat Indenting Apparatus, as improved by us, Gilmore's Needles, Jackson's specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

CHICAGO



McCaslin Conveyor over Storage Bin Handling Hot Clinker

The McCaslin Conveyor

Acknowledged by Competent Engineers as the best Conveyor in the world for handling hot clinker, stone, etc., in **CEMENT PLANTS.**

Low Cost of Maintenance Absence of Shut Downs
Maximum of Efficiency

Manufactured solely by

Mead, Morrison Mfg. Co.

BOSTON

NEW YORK

CHICAGO

Catalog on Request

Send Us Your Specifications for an Estimate



STEEL BARS

FOR

CONCRETE REINFORCEMENT

Plain Rounds, Plain Squares, Square Twisted

All sizes from 5-16 to 1¼ inches. Flat bars from ¼ x 1 inch to ¾ x 2½ inches

WE GUARANTEE IMMEDIATE DELIVERY

No extra charge for cutting to length

FRANKLIN STEEL COMPANY, Franklin, Penn.

Location for Cement Plant

Extensive Deposits of Raw Material. Proximity to Large and Growing Markets. Low-Priced Fuel Supply.



THERE ARE several desirable locations for Portland Cement Plants along the Santa Fe, where the advantages enumerated are to be found. If you are interested you can secure full and detailed information by addressing this office.

The SANTA FE is glad at all times to co-operate with those seeking locations or desirous of investigating conditions in territory tributary to its line. Correspondence from interested manufacturers is invited.

WESLEY MERRITT, Industrial Commissioner A., T. & S. F. Ry.

1122 Railway Exchange Building

CHICAGO, ILL.

Face Your Blocks

Make Them White

Do You
Use

WHITE SAND

Leading contractors specify our pure White, Washed and Screened Silica Sand for fine work in ornamental stone, block facing, porch work, ornamental lawn fixtures, vases, etc.
This sand is shipped both DRY and DAMP.
Prices and Samples on request.

BALLOU'S WHITE SAND COMPANY
MILLINGTON, ILLINOIS

The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa.

WANT COLUMNS.

Advertisements in this column are inserted at the rate of two dollars per inch per issue—and no advertisement will be taken less than two dollars and must be paid strictly in advance.

WANTED.

Position by chemist having 8 years' experience, 3 years as chief chemist. References furnished. Address A. A. B., care Cement & Eng. News.

FOR SALE

2 -100-in. FANS or BLOWERS
1--110-In, " " "

Water Jacketed Bearings—Pulley Drive— Upward Discharge— Made by the American Blower Co., Detroit, Mich. Used only a few weeks. In good condition. Will be sold at a Bargain.

ADDRESS: Peninsular Portland Cement Co.
JACKSON, MICH.

WANTED.

If you are interested in pumps of latest and best styles, send to us for book and catalogue. Pumps of all styles and for all used. The Columbus Steam Pump Works, West Broad street, Columbus, Ohio.

WANTED.

Position as sales manager or assistant sales manager for cement plant. Have six years experience. At present employed, but desire change. Address G. D., care Cement and Engineering News.

POSITION WANTED.

Assistant Chemist (Lehigh University), desires position. Am also a first class accountant. Four years' experience. Address Chemist., 330 Fourth St., South Bethlehem, Pa.

POSITION WANTED.

By young man 38 years old. Ten years' experience as Chemist, Assistant Superintendent and Superintendent in the manufacture of Portland Cement by both dry and wet process. At present employed, but desires change of location. Address, W. H. Simmons, care Cement & Engineering News.

MEACHAM & WRIGHT CO.

Sales Agents

IMPROVED

UTICA HYDRAULIC CEMENT

And Dealers in

LEHIGH PORTLAND CEMENT

Telephone Main 59 206 La Salle Street, Chicago

F. D. MEACHAM, Pres.
S. P. BLOUNT, Treas.

F. S. WRIGHT, Vice-Pres.
C. M. FOSTER, Secy.

Send for a copy of these Books

The Hardening of Cement Under Water

ALSO

The Hardening Process of Hydraulic Cements

By Dr. W. Michaelis, Sr.

Papers read before the German Portland Cement Manufacturers at Berlin, Germany, March 9, 1909

Translated by Dr. W. Michaelis, Jr.

PRICE, FIFTY CENTS EACH

Cement & Engineering News, - - 22 Fifth Avenue, Chicago

The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker
1½ inches diameter from the kiln
and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

It saves cost in attention.

MANUFACTURED BY

BRADLEY PULVERIZER CO.

37 Walbrook
LONDON, E. C.

92 State Street
BOSTON



Hess Furnaces



No. 45

"Leader" Hess
Steel Furnace

Price **\$49.00**

Delivered East of Omaha and
North of Ohio River
Pipes and Registers Extra

for the past 7 years, have been
sent to customers in every state
in the Union, freight prepaid,

On Approval

and the money held back till
sixty winter days of actual trial
have proved that all our claims
for superiority have been ful-
filled.

Isn't this worth looking into? Could
we offer such liberal terms if we didn't
know that the Hess Furnace excels in
service, simplicity, efficiency, economy?

All we ask of you, if you need a fur-
nace, is to investigate—to put your
name on a postal card, mail to us and
ask us for our booklet "Modern Fur-
nace Heating." This booklet is an au-
thority on furnace heating, and copies
have been requested by many colleges,
libraries, etc., for reference in engi-
neering and mechanical courses. It
instructs fully in the principles and
practice of furnace heating, and should
be in the hands of every builder and
house owner. It is free on request.

In Buying Direct

**From Our Factory You Pay Only
One Profit—A Small, Factory Profit.**

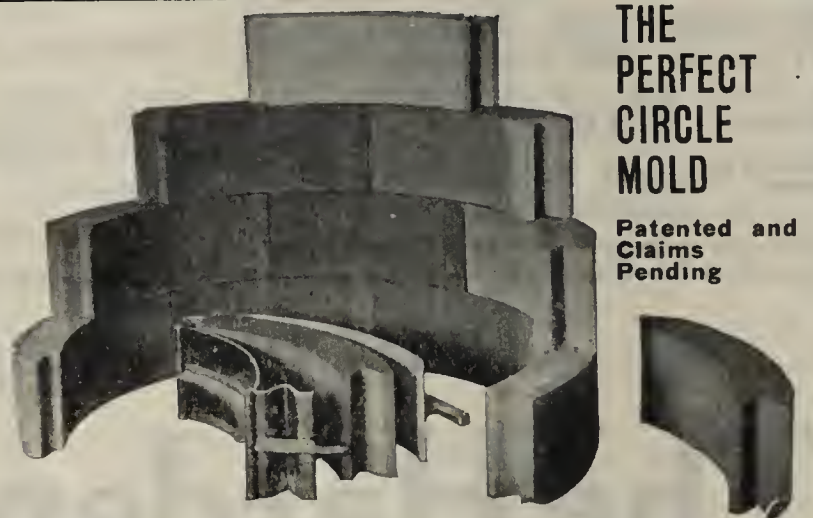
Our prices are not inflated with the usual cost for salesmen, branch
stores, agents' and dealers' profits. The factory profit only, satisfies
us, and you will be surprised at how much we can save you.

Special Heating Plan Free Before You Order

Let us have our experts prepare a special plan for heating your build-
ing. It will cost you nothing, and put you under no obligation to buy
of us. Our thirty-six years of experience in designing heating equip-
ments makes this free plan valuable to you.

Ask us more about it. A postal card today will serve the purpose.

Hess Warming & Ventilating Co.
919 Tacoma Bld., Chicago.



THE
PERFECT
CIRCLE
MOLD

Patented and
Claims
Pending

The Perfect Mold was invented by C. S. Wert, of Kendallville, Ind. Manu-
factured in any sizes. In ordering give the inside diameter. The three most
in use are No. 1, with diameter of its circumference 3 ft; No. 2, diameter of its
circumference, 5 ft. No. 3, diameter of its circumference, 7 ft. Also 10, 12
and 14 ft. Diameters—used for silos.

CONSTRUCTION.

The circle mold is built of No. 10 gauge sheet steel,
reinforced with T-Iron. The molds are 8-in. high, 4-in.
thick, making them strong and durable. These curbing
blocks can be made on the ground or floor, or can be made
on wooden pallets. Those in the concrete manufacturing
business cannot afford to do without one of these molds,
as all up-to-date concrete plants are equipping themselves
with one or more of my curbing molds, for they all see
at a glance their importance and utility, simplicity in
operation, durable construction, and lasting qualities in
products, as well as completion of a well equipped plant.
showing the ability of a man's occupation or business. These
molds are no experiment but an up-to-date invention,
practicable, durable, simple and useful, and are only appre-
ciated by those who have them in store. Selling at a price
within reach of all. The output of these molds is greater
than can be produced on any other mold, thus reducing
the labor and cost of making the products, and also in-
creasing the profits.

These molds will enable you to make better products
than can be produced on any other machine or model and
sell for more money. Just what an up-to-date concrete
constructor needs is an up-to-date plant. In a class by
themselves, possessing many advantages over all others.
Absolutely the best and cheapest molds ever offered to
the public. Write for prices.

C. S. WERT, 602 N. Main Street, Kendallville, Indiana.

THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

Design, Construction, Remodeling and Operation
of Portland Cement Plants

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street
New YorkCanadian Express Bldg.,
Montreal, Can.1121 The Rookery
Chicago425 Washington St.
San Francisco, Cal.Monongahela Bank Bldg.
PittsburghSyndicate Trust Bldg.,
St. Louis, Mo.Norfolk House, Cannon St.
E. C., London

The Osborn Engineering Co. Civil, Mechanical and Electrical Engineers

OSBORN BUILDING, CLEVELAND, O.

Experts in the Designing of
CEMENT PLANTS.

Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of Cement Machinery

42 NORTH 16TH STREET

:::

PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

Northrup Bldg., Iola, Kas.

Cement Engineers

Just Out

Architects' and Engineers' Hand Book on
Reinforced Concrete
Construction

ONLY ONE DOLLAR

CEMENT & ENGINEERING NEWS

22 Fifth Avenue, Chicago

MEDUSA WATER-PROOF COMPOUND

Makes all concrete watertight

Write for pamphlet describing its use. Do not accept a substitute, as there are many adulterated compounds on the market
It is not a wash, or an experiment



Illustration of Soulard Public Bath House, St. Louis, Mo. Pool, Floors, Steps and Walls surfaced with Medusa Pure White Stainless Portland Cement, containing Medusa Water-proof Compound.



Sandusky Portland Cement Company
Sandusky, Ohio

Write for free Sample of our White Portland Cement

Obtain our prices on Medusa Portland. Annual Capacity, 1,500,000 bbls.

IRON-ORE CEMENT

The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in place of Portland cement for all Marine Construction.

Send for Literature, Etc.

Worm-Cox Company
SOLE AGENTS
Marquette Building, Chicago

LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GROUND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.,
ALLENTOWN, PA.
Western Office:
725 ROCKEFELLER BUILDING,
CLEVELAND, OHIO.

ALPHA PORTLAND CEMENT....
Alpha, N. J.
Works: Martins Creek, Pa.
Manheim, W. Va.

Quality unexcelled The Recognized Standard American Brand Always Uniform
ALPHA PORTLAND CEMENT CO.
Manufacturers but one grade—strictly straight Portland
General Office, EASTON, PA.

"COMPETITION Demands Business Economy

Established a system of economical buying, and note the results by the increased profits of your business.
Our ability to save you money has ceased to be questioned, but accepted as a matter of fact by the public in general.
If you have failed to avail yourself of the money saving opportunities we offer, you are earnestly requested to delay no longer, but send us your inquiry at once.

ROCK CRUSHERS.

1—9 x 15 Allis Chalmers Jaw Crusher.

ROCK DRILLS.

6—Ingersoll-Sargeant Rock Drills, size 3 1/4 inches.
6—Ingersoll-Sargeant Rock Drills, size 3 1/2 inches.
Fitted for steam or air.

HOISTING ENGINES.

1—12x16 double cylinder, heavy duty LIDGERWOOD hoisting engine.
1—6x8 Marine Iron Works double cylinder, single drums, reversible in steam chest.

5,000 rolls rubber, leather and canvas belting, structural iron, shafting, pulleys, couplings, steel wire and manila rope. Smoke stacks, corrugated roofing and siding, hose hydrants, tanks, and supplies of all kinds. We can save you money on anything you require.

SEND FOR OUR NEW 500-PAGE CATALOG NO. 962.

A wonderful book of facts and information of the utmost value to purchasing agents in all lines of business. Send for one to-day. It will cost you nothing.

Chicago House Wrecking Co., 35th and Iron Streets, Chicago, Ill.

PUMPS.

3—24 inch Centrifugal pumps, 2 to 3,000,000 gallons capacity.
1—20x13x12 Wheeler & Tappen Duplex Pump.
1—20x13x12 Cameron Single Acting Pump.
1—12x7x12 Smithvalve Duplex Pump.
1—8x12x12 Smithvalve Duplex Pump.
7—6x4x6 Dean Steam Pumps, new.
6—4 1/2 x 2 3/4 x 4 Dean Duplex Pumps, new.
8—3x2x3 Duplex Steam Pumps, new.

LOCOMOTIVES AND CRANES.

4—9x16 inches Baldwin. 36 inch gauge.
1—5 ton Brown Locomotive Cranes, 25 foot Booms.

IRON PIPE.

70,000 ft. 1 inch Standard Pipe, 35,000 ft. 1 1/4 inch Casing.
50,000 ft. 1 1/2 inch Standard Pipe, 40,000 ft. 3 1/4 inch Casing.
30,000 ft. 2 inch Standard Pipe, 60,000 ft. 3 3/4 inch Casing.
2,000 ft. 10 inch Standard Pipe, 8,000 ft. 5 5/8 inch Casing.
4,000 ft. 12 inch Standard Pipe, 9,000 ft. 6 1/4 inch Casing.
30,000 ft. 8 inch Cast Iron Pipe, 1,000 ft. 6 5/8 inch Casing.
300 ft. 24 inch Cast Iron Pipe, 1,250 ft. 8 1/4 inch Casing.
1,500 ft. Riveted Steel Pipe, 24 inch to 72 inch diameter.

Colonial Trust & Savings Bank

A BANK FOR THE PEOPLE

Pays 3% on Savings Accounts

Capital and Surplus, \$1,106,620

YOUR ACCOUNT INVITED

205 La Salle Street, - - - - - Chicago, Ill



THE IMPROVED DIETRICH'S CLAMP

and Form System for Hollow Walls

By the use of the Improved Dietrichs Clamp and Form System for Hollow Walls the

**COST OF CONCRETE
CONSTRUCTION IS
REDUCED 50%**

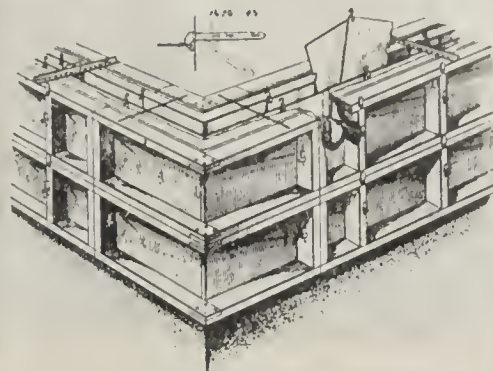
and the builder also secures a

**PERFECT
DAMP-PROOF WALL**

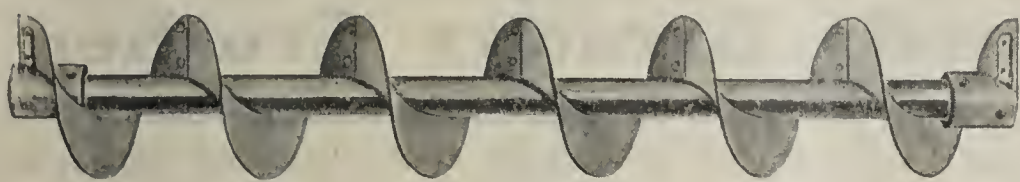
This system is based on the panel principle and employs removable sheet iron inner forms with sheet iron spacer. Corners, doors and window openings are provided for.

Write for pamphlet giving full information

DIETRICH'S CLAMP CO.
LITTLE FERRY, N. J.



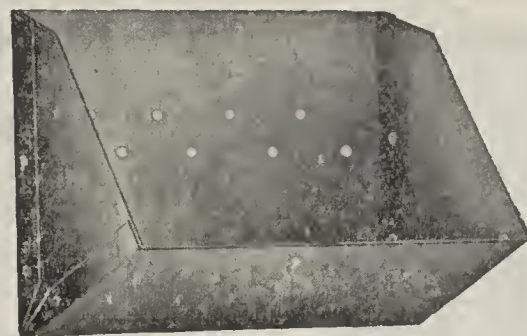
ELEVATING—CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys, Shafting, Shaft Bearings, Link Belting, Special Chains

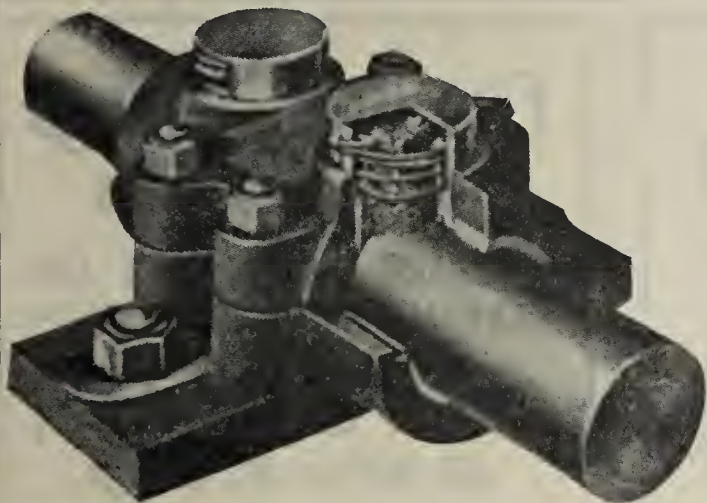


HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES.
Catalog for the asking.

SKILLIN & RICHARDS MFG. CO., CHICAGO

Your Coal Bill



Is something you constantly watch. If you could find an engineer who would save 10% you would pay him a large salary.

Did you ever stop to think that a reduction of friction throughout your plant, would reduce the amount of power necessary, hence a reduction in coal consumption?

You will of course admit that perfect lubrication would greatly reduce friction.

The new VAN DOREN LUBRICATING DEVICE is designed to give PERFECT LUBRICATION, and it DOES WHAT IT IS DESIGNED TO DO.

Your saving on oil, will in less than a year pay the cost of installation.

Your COAL SAVING is YOURS from the start.

Send for Complete Information.

C. J. VAN DOREN CO., 426 WEST MADISON STREET
CHICAGO

These are Weller-Made

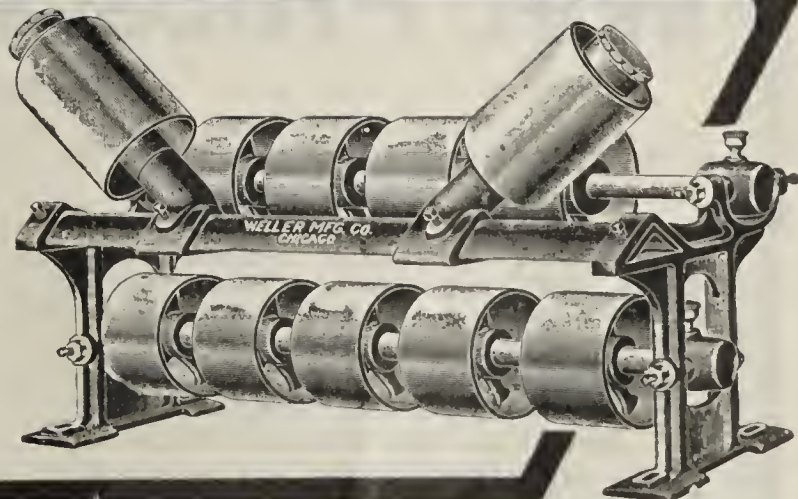
—and that is a guarantee wherein they are well made.

The Standard Combination Throughing Carrier Style B. is not only unique in construction because of its various good features, but it's a real money and worry saver to those upon whom devolves the maintenance of belt conveyors. Our catalog explains the "why and wherefore." You'd do well to write for it to-day.

The Heavy Steel Bucket illustrated is chiefly used in Cement Plants. Its curved inside bottom insures free delivery and is very desirable therefore, for handling certain classes of material. This bucket has supplanted the ones of malleable iron; its use is a proved value.

Write for our No. 19 512-page Catalog, showing complete line of Elevating, Conveying and Power Transmitting machinery. It's to our mutual benefit that you should have it. The catalog tells "why." Write to-day.

WELLER MFG. CO., CHICAGO





Dolese & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world. Machinery throughout installed by us.

OLSON BROS. & CO. Engineers and Contractors

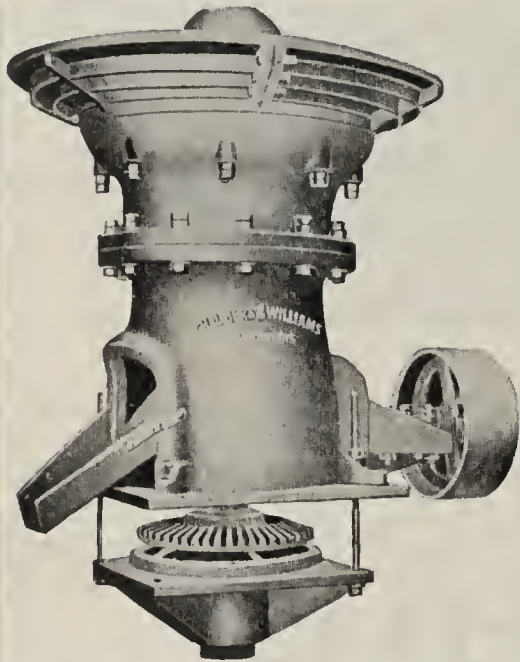
Cement Mill Machinery Erected, Stone Crushing
Plants Equipped and Erected. :: :: :: ::

ALSO COMPLETE PLANTS FOR HANDLING
COAL, SAND, GRAVEL, ORES, ASHES, ETC.

MODERN POWER TRANSMISSION
Elevating and Conveying Machinery.

Tanks and Vats, Especially in Connection with Machinery

2418-22 Bloomingdale Ave., Chicago



Kennedy Gyratory Crusher

The only Crusher built with a ball and socket eccentric which will lend itself to any change in the inclination of the main shaft. Improved hopper, more efficient dust collars.

— ALSO —

Cement Making Machinery

Kilns, Dryers, Tube Mills, Ball Mills, Elevators, Conveyors, Feeders,
Revolving Screens and Crushing Rolls.

Chalmers & Williams Inc.;

1927 Commercial National Bank Building, - - - Chicago

120 Liberty Street, New York



TRADE MARK

PENINSULAR PORTLAND CEMENT

Acknowledged by competent Architects and Engineers
to be unequalled for fineness, wonderful development
of strength and sand carrying capacity.

"THE BEST IS THE CHEAPEST"

Address

Peninsular Portland Cement Co.
JACKSON, MICHIGAN.

Fire Brick Linings For Cement Kilns

STANDARD TESTING SAND AND
GENERAL BUILDING SUPPLIES

Garden City Sand Co.,
188 Madison St., Chicago

Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - - 645 No. Sixth St., Terre Haute, Ind.

Apparatus for Chemical and Physical Testing of Cement

EIMER & AMEND

205-211 Third Avenue, New York City

MANUFACTURERS OF

Chemical Apparatus, C. P. Chemicals and Reagents

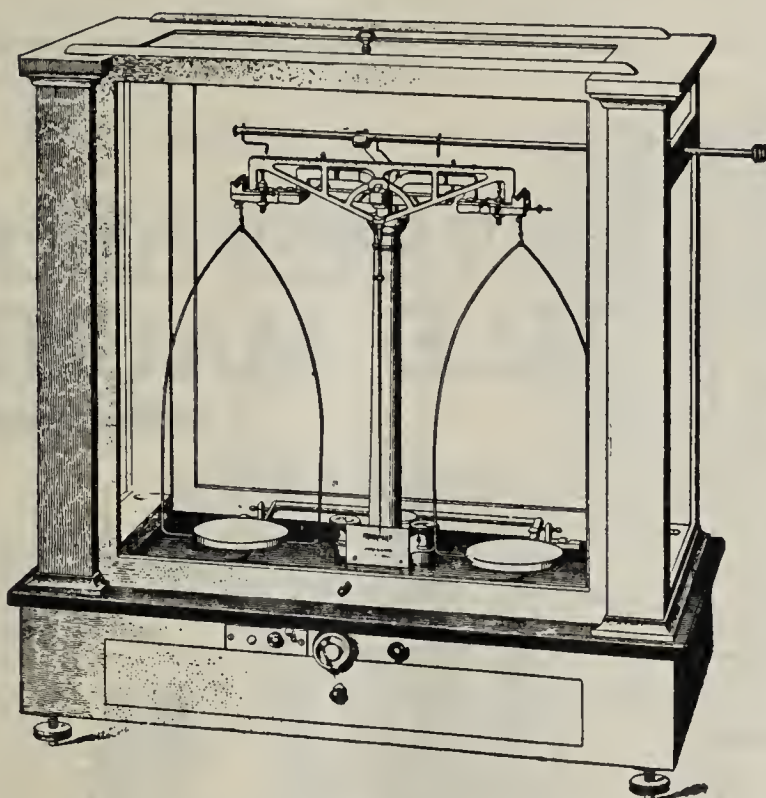
Cement Testing Machines.

Vicat's Needle.

Cement Briquette Moulds.

Gilmore Needle.

Standard Sieves of Exact Meshes.



*Williams' Sp. Gr. Balance.
Specially adapted for determining
Sp. Gr. of Cement.*

(Descriptive Pamphlet sent on request)

*Schumann's, Le Chatelier's,
Jackson's and Candelot's
Apparatus for Sp. Gr. of
Cement.*

Filter Papers, C. S. & S. etc.

The "E. & A." Gold Plated Short Beam Analytical Balance

Capacity, 200 grm.; Sensibility, 1-20th mgr.

Perfect in Construction and Adjustment

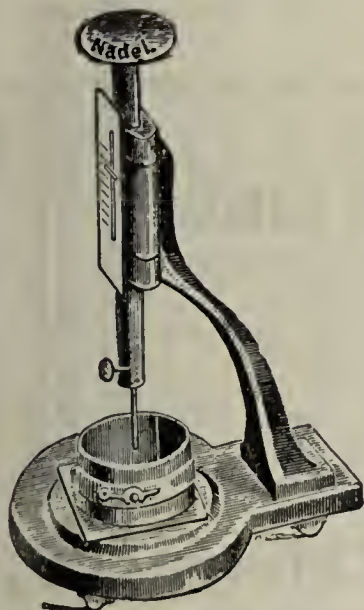
Headquarters for

CALORIMETERS AND PYROMETERS

EMERSON FUEL CALORIMETER

The most modern and efficient BOMB Calorimeter for accurate determination of the heating value of fuel. Specially constructed for use by the Steam Engineer as well as the Chemist.

(Descriptive Booklet sent on request.)



WANNER OPTICAL PYROMETER

The most accurately reading instrument on the market. Simple in operation. Very Portable.

(Our large illustrated Catalogue gladly sent to Chemists on application.)



IT WILL PAY YOU TO USE CROWN HYDRATE

(HIGH CALCIUM HYDRATED LIME)

For Waterproofing and Concrete

It Improves Its Strength and Color. Ask the

Marblehead Lime Company

KANSAS CITY

CHICAGO

German-American Port-
land Cement Works

OWL CEMENT

Illustrated Pamphlet Mailed on Request

E. L. COX, General Sales Agent,
1527 Marquette Bldg.,

Works: La Salle, Ill. CHICAGO

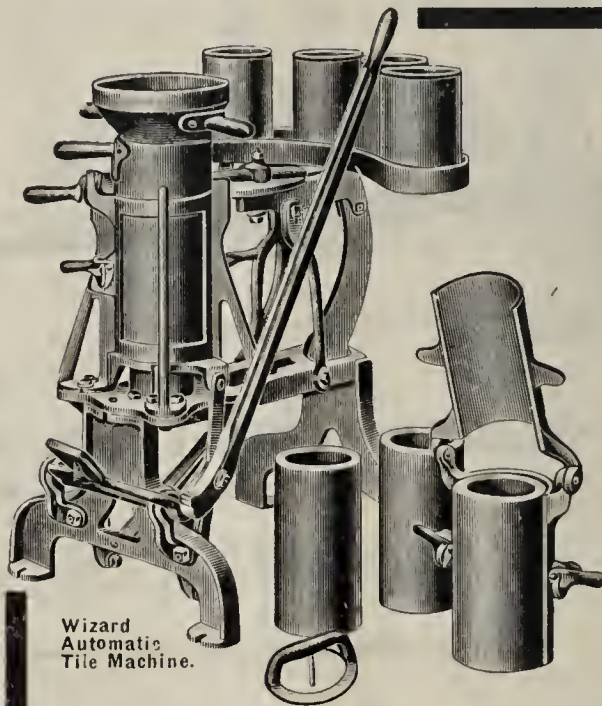
Peerless Portland Cement

MANUFACTURED AT UNION
CITY, MICH.

Every Barrel Guaranteed

Fineness, Uniformity of Color
and Sand Carrying Qualities
equal to any Portland Ce-
ment Manufactured

HIGH SPEED CONCRETE \$ 41⁵⁰ TILE MACHINE



Wizard
Automatic
Tile Machine.

UNDER ACTUAL TEST
two of these Wizard Tile
Machines operated by five men
have turned out as many con-
crete tile in one day as the big
\$1,000 machines which require
an engine and seven men to
operate. A day's output of the
Wizard Tile Machine is from 900
to 1,200 perfect tile 10 inches
long with 4-inch opening and 5/8-
inch wall, and selling readily
for 7 cents
each. \$63.00
to \$84.00 is
the value of
your day's
product, and
the profit
above cost of
material and
labor is about
\$35.00 a day.



The Wizard Block
Machine. Fastest and
best on the market.

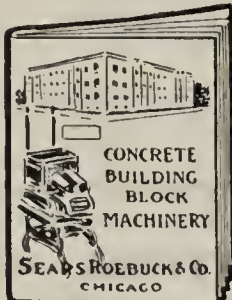
Wizard Automatic Block Machine, \$42.50

The only really successful and by far the fastest automatic block
machine on the market, sold at less than half the price others
charge for inferior machines. Guaranteed to make perfect blocks
on the face down principle. Faster than any other machine sold.

Our Triumph Block Machine at \$16.95 is by far the best low
priced block machine on the market.

Fence Post Molds

Our Fence Post Molds, making concrete fence posts either by semi-dry
or slush system, are the best molds on the market and are sold at lower
prices than ever before asked for a practical mold.



Send today for Concrete
Catalog No. 79C36

Write for This Free Catalog

Handsome molds for post columns, piers, balusters
and capitals. A full and complete line at record
breaking low prices. We sell more concrete block
machines, molds and supplies than any other con-
cern in the world. Our catalog tells the story. It
is the most complete book of information on con-
crete machinery, whether you are contemplating
concrete building for yourself or for others. This
book shows you how to save money on your own
concrete buildings and how to make a profit in the
concrete material business. We will send it free
on request the very day you ask for it.



Triumph
Fence Post
Mold.
\$7.95

Sears, Roebuck and Co., Chicago

Why Don't You?

Make Your Own Cement in the manufacture of SILICATE BRICK and STONE out of Sand, Slag, Quarry-Waste, or any silicious material, with a small percentage of Lime.

Our "DIVISION-METHOD" will produce a higher grade product at a lower cost than can be made under any other process.

"RAW MATERIAL TO FINISHED PRODUCT—24 HOURS."

We furnish all Machinery, erect complete Factory and turn it over in perfect running order.

Write for full particulars to

International Sand-Lime Brick & Machinery Co.

90 WEST STREET, NEW YORK CITY

ENGINEERS AND CONTRACTORS FOR SILICATE BRICK AND STONE FACTORIES.

The Right Power For Concrete Workers

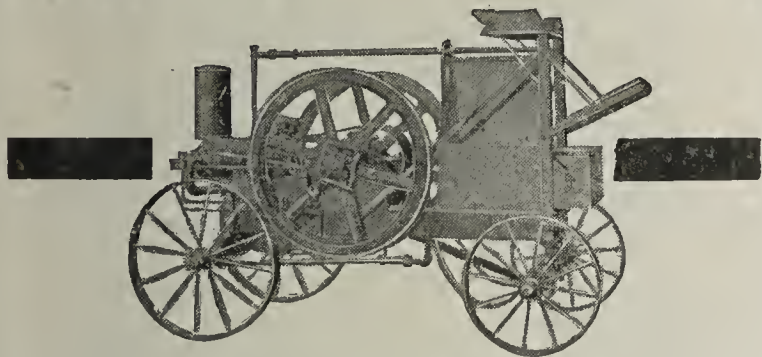
YOUR engine is in the I H C line. For you want greatest efficiency, combined with economy, simplicity, strength and durability. Your engine must work hard, in all kinds of weather, under the most trying conditions. That is why

I H C Gasoline Engines

have been the choice of concrete workers who want the right power. See the local International agent about the I H C engine to meet your requirements. Any horsepower, vertical or horizontal, stationary or portable, air or water cooled, mounted on skids or trucks. Catalogue and full information from agent or direct from us.

International Harvester Company of America

INCORPORATED
41 Harvester Building, CHICAGO, U. S. A.






OFFICES

- BIRMINGHAM
- BOSTON
- BUFFALO
- CHICAGO
- CINCINNATI
- DENVER
- DULUTH
- HAZLETON
- HOUGHTON
- HUNTINGTON
- JOPLIN
- KANSAS CITY
- MEMPHIS
- MEXICO CITY
- NASHVILLE
- NEW ORLEANS
- NEW YORK
- PHILADELPHIA
- PITTSBURG, KAS.
- PITTSBURGH, PA.
- PORTLAND
- SALT LAKE CITY
- SAN FRANCISCO
- SCRANTON
- SEATTLE
- SHREVEPORT
- SPOKANE
- SPRINGFIELD
- ST. LOUIS
- TERRE HAUTE

DU PONT BLASTING

GELATIN is recommended for QUARRYING very hard rock. It can be used in the same bore hole with other Du Pont High Explosives.







E. I. DU PONT DE NEMOURS POWDER CO. Wilmington, Del. U.S.A.

COPYRIGHTED BY E. I. DU PONT DE NEMOURS POWDER COMPANY, 1910

CHARLES F. McKENNA, Ph.D.

Inspection of Cement

and all other Engineering Materials. Examination of Properties and of Economical Operation of Works.

**Consulting and General Practice in
Chemistry, Technology, Chemical
Engineering and Chemico-
Legal Cases.**

Long Distance Telephone. Cable Address: PLAT PEARL
Laboratories: 221 Pearl St., New York City
Offices: 50 Church Street

Hotel Cumberland

NEW YORK

S.W. Cor. Broadway and 54th St.

Near 50th Street Subway Station and 53d Street Elevated

**HEADQUARTERS FOR THE CEMENT
AND MACHINERY MEN.**

New Modern Fire Proof

All Outside Rooms. No Carpets. All Oriental Rugs.

Transient Rates \$2.50 with Bath and up.

10 minutes walk to 20 theatres.

Send for Booklet.

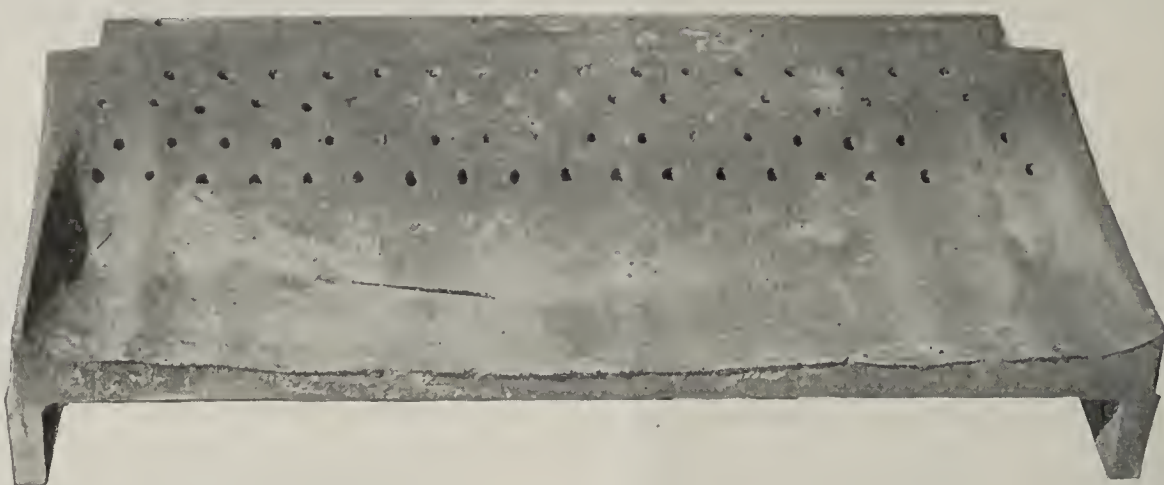
HARRY P. SIMPSON, Formerly with Hotel Imperial.

R. J. BINGHAM, Formerly with Hotel Woodward

TISCO APPLICATIONS

INVARIABLY SHOW ECONOMY IN THE FIELD OF WEAR AND TEAR

WE SOLICIT
A TALE
OF
YOUR
TROUBLES.



There are
ofttimes hard
places that are
weak spots
even in the
best cement
plants.

For the same money the Ball Mill Plate above ground approximately 228,000 barrels more clinker than the plates which it replaced.

TISCO applications in single mills have established economies as high as one and three-eighths cents per barrel.

MANGANESE STEEL CHAINS

Elevating
GRIT PROOF
INDESTRUCTO

Power
Transmitting
WEARLESS

Conveying
STRAIGHT LINE
RIVETLESS

RECOMMENDED APPLICATIONS FOR

STEAM SHOVELS
CRUSHERS
BALL MILLS
FULLER MILLS
KENT MILLS

TUBE MILLS
KOMINUTERS
RAYMOND MILLS
PULVERIZERS
CONVEYORS

BONNOT MILLS
SPROCKETS
CAR WHEELS
SCREENS
GEARING

**Taylor Iron & Steel Co., HIGH BRIDGE,
New Jersey**

THIS POWERFUL AUTOMATIC BLOCK MACHINE

Makes 1000 Blocks 24"x12"x9" in 10 Hours.

Each block receives **20 TONS**
"SQUEEZE" twice from opposite di-
rections.

Ours is the only 1 piece, double air
space, building block on the market.

WESTERN SHAW BLOCK CO.

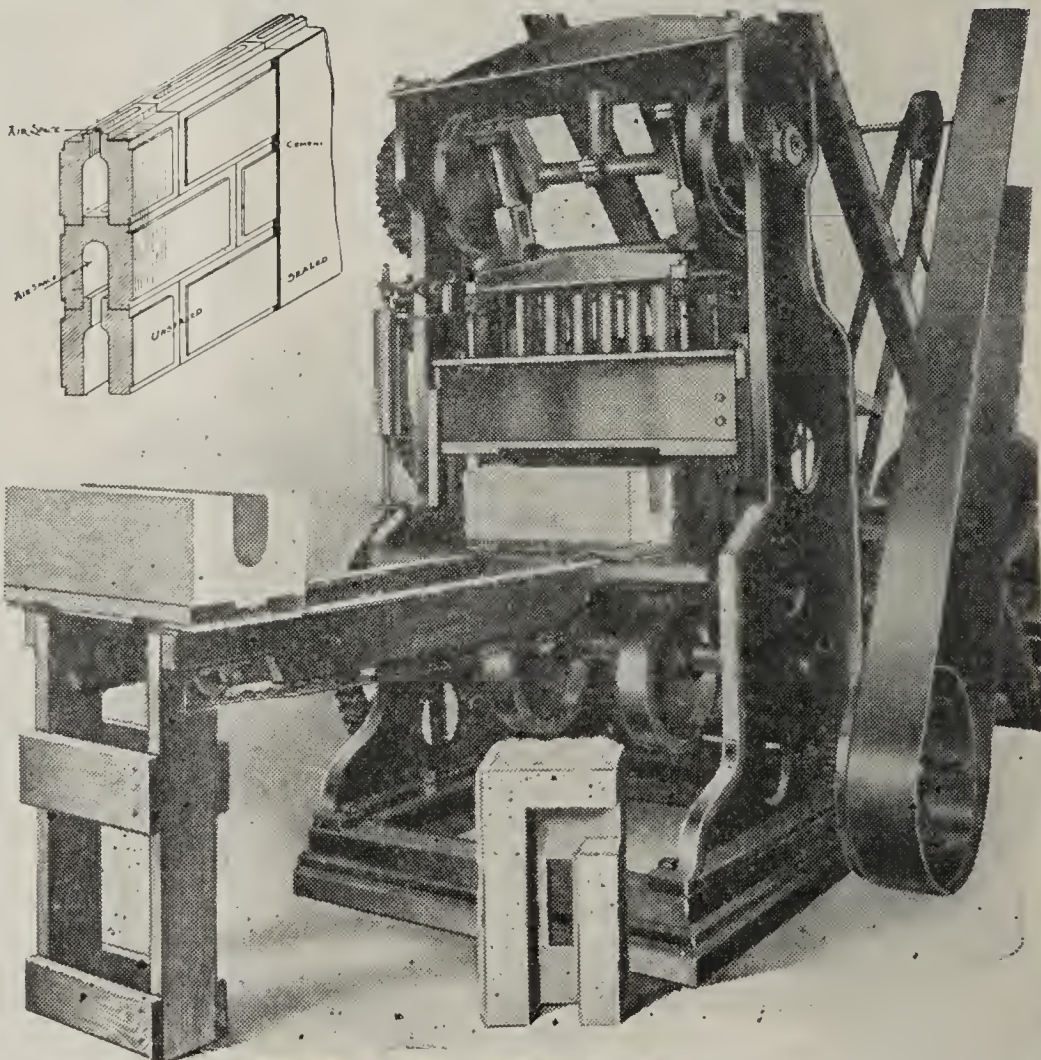
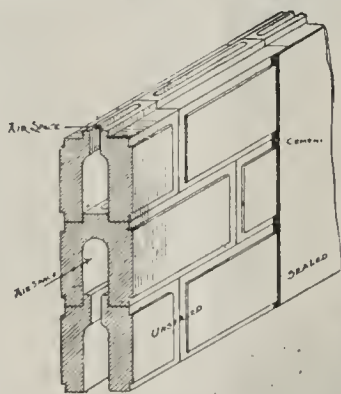
Room 317

218 LA SALLE ST., :: CHICAGO, ILL.

Our terms permit you to pay for the
machine with a small per cent of your
profits.

With this plant you can successfully
compete with common brick, and be
independent of the competition of any
other building block machine.

Consult your own interest and get
in on this live proposition.





Concrete Mixer Theories

Grow Into Definite Mixing Knowledge

When Every Mixing Action Is A
Known Positive Mechanical Force



There's An Individuality About Koehring Mixing—It's Known Mixing

The drum is a plain cylinder with heavy cast iron heads, but, bear in mind, it's made without *deflecting faces* or other *obstructions* to limit the *end-to-end* mixing.

The mixing blades are so arranged that they not only *lift and pour* the aggregates from the side but carry them alternately from *end-to-end* and *break them over* against the heavy heads.

There's no *guess-work* about it—no rolling over in the center of the drum—every action of the aggregates is performed by a *known, positive mechanical force*.

But there's another mixing than this in the Koehring Mixer.

—When not in discharge position, the inner end of the discharge chute is tilted downward.

—Material carried up by the mixing scoops at the side is discharged onto the inwardly and downwardly extending chute and descends from the inner end in a *continuous flow*, the entire width of the chute, and falls to the bottom at *right angles*, to that from the mixing scoops and the *end-to-end* mixing.

That's *three independent mixings*, every one of them a *known mixing* and no *theories* required to explain them.

Three known mixings in one, is why the *Koehring Mixer* is the *fastest in existence*.

But known mixing is not its only improvements over old style batch mixers.

—The trunnion rollers are cast with *wide faces*, *chilled* to extreme hardness and placed wide apart at the extreme ends of the drum.

This not only guarantees a *stable equilibrium* to the drum but insures its maintaining *perfect alignment* even after years of service. The outer end of the discharge chute does not tilt downward, affording ample clearance for wheelbarrows, even in the *smallest sizes*.

There are other *worth considering* features, that every mechanical mind *knows* are correct in principle, explained in our new catalog. Do not fail to write for it at once, being sure to mention "Catalog B."

KOEHRING MACHINE CO., 614-616 GERMANIA BUILDING
MILWAUKEE, WIS., U. S. A.



ATLAS

CEMENT LIBRARY

Concrete Construction about the Home and on the Farm	-	Free
Concrete Houses and Cottages. Vol. I. Large Houses.	-	\$1.00
Vol. II. Small Houses.	-	1.00
Concrete in Highway Construction	-	1.00
Reinforced Concrete in Factory Construction (delivery charge).	-	.10
Concrete in Railroad Construction	-	1.00
Concrete Cottages	-	Free
Concrete Country Residences (out of print)	-	\$1.00
Concrete Garages	-	Free

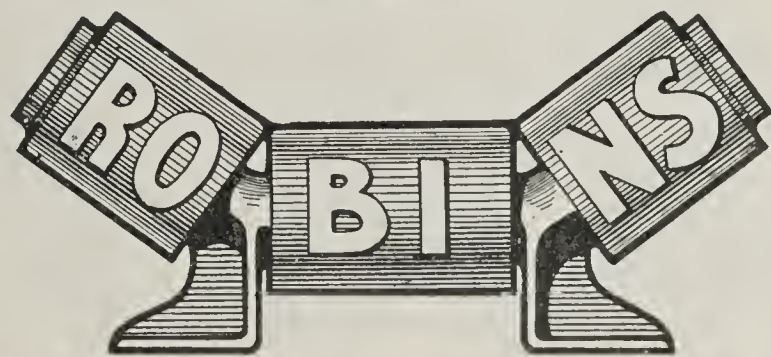
The books in this library contain the most complete and exhaustive information ever published by a manufacturing company in the interest of any industry. They have been compiled at an enormous expense by the most expert engineers in the country who have striven to present the subjects in a clear, concise and unbiased manner.

Send for any or all of them to

THE ATLAS PORTLAND CEMENT CO.

Dept. 3 30 Broad Street New York

Productive capacity over 50,000 barrels per day—
The largest in the world.



BELT CONVEYORS

For Use in

Cement Plants

Have No Equal

We have some interesting data on this subject which is yours for the asking.

Robins Conveying Belt Co.

THOMAS ROBINS
President

Passaic, N. J. G. KEMBLE BALDWIN
Chief Engineer

NEW YORK

CHICAGO

"Safest to use, because richest in Bitumen"

"Pioneer"

OUR asphaltic products were first introduced in 1896. For 14 years they have been undergoing the hard practical tests of every day use, and Engineers of repute in all parts of the United States are specifying "Pioneer" Asphalt materials today, because these materials have proven superior to all others.

Wherever there is a reservoir to be waterproofed specifications should be adopted which will prohibit the use of an inferior grade of asphalt. Wherever pipe line construction is in progress the question of *protection and preservation* of the pipe ought not to be decided upon mere claims, but the rigid demands of *specifications that are safe* should be enforced as a check upon lax methods and inferior materials.

"Pioneer" Reservoir Waterproofing Asphalt "Pioneer" Mineral Rubber Pipe Coating

Here are two commodities that will meet the demands of the specifications suggested. They are not experimental, but have both been used with the highest success for years, and under the severest conditions.

Over 99½% Pure The superior quality of our asphalt is a *proved-out* proposition—a *known quantity*. Our own mines in Utah contain immense deposits of the purest hydrocarbon known, our Gilsonite analyzing over 99½ per cent pure bitumen. In any true technical comparison of values "Pioneer" Mineral Rubber Pipe Coating and "Pioneer" Reservoir

Waterproofing Asphalt will readily demonstrate the superiority which has made them practically non-competitive. **Specifications** Send for our specifications and be safeguarded against those asphalt (which are offered as being equal to "Pioneer") the employment of which has, in spite of claims, proven them to be inefficient.

The American Asphaltum & Rubber Co.
600-614 Harvester Bldg.,
Chicago, Ill.

**A
14
Year
Record
of Success**

NOT THE NOON HOUR



REPAIRS ON THE MAIN DRIVE.

Perhaps this has happened in *your* plant? The belting gives out. Machinery stops. Hands idle. But expenses run right along. Such mishaps can be avoided and highest efficiency permanently assured by using

RELIANCE Guaranteed Leather Belting Repair Bills Reduced

For Tube, Ball, Griffin and Fuller Mills it is unsurpassable. Every Reliance Belt for cement work is protected by a special dressing.

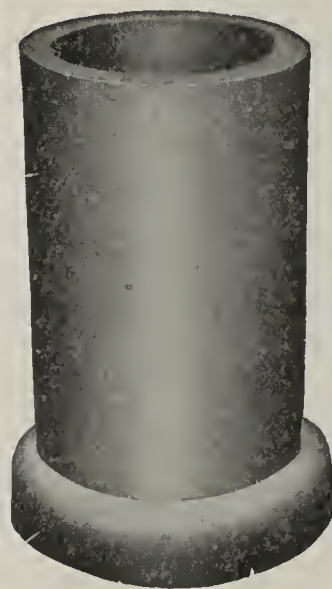
Write for booklet.

Chicago Belting Company
12-22 Green St., Chicago



Branches: New Orleans, 431 Gravier St. New York, 71 Dey St.
Portland, Ore., 94 First St. Philadelphia, 234 N. Third St.

Cement Sewer Pipe Is the Large Profit End Of the Concrete Business



Miracle Cement Pipe Molds have been in general use throughout America and many foreign countries for the past five years, and are giving universal satisfaction. Within the past three months large plants have been equipped for the manufacture of cement pipe by the use of Miracle molds in the cities of Denver, Tacoma and Seattle, which cities have opened their specifications to the use of cement sewer pipe.

Special Sewer Pipe Catalog (Just Out.)
New Mixer Book (Just Out) Get one.
Sent FREE to readers of this Magazine.

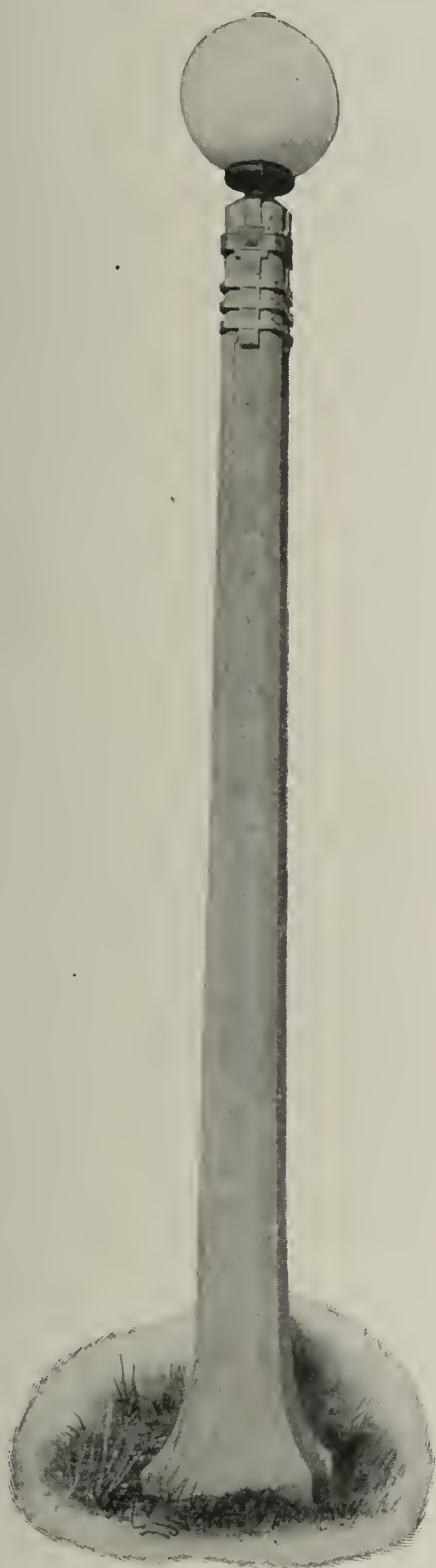
MIRACLE PRESSED STONE CO.

Department "L."
MINNEAPOLIS, MINN.

CEMENT

.....AND.....

ENGINEERING NEWS



Detail View of Concrete
Electric Light Standard.

Concrete in the "City Beautiful"



Concrete Electric Light Standards, Lincoln Park
Boulevard, Chicago.

The "City Beautiful" movement inaugurated in several of our large cities in recent years has displayed in a remarkable manner the value of concrete as an agent for the beautification of boulevards and parks. Wherever improvements of an artistic nature are proposed for the park systems some new use for concrete is discovered or a common application adapted to existing conditions. Walks, fountains, curbs and copings, benches, light standards, ornamental fences and posts pavillions, pergolas and buildings of all kinds constructed of concrete are becoming common and as a rule concrete lends itself to such construction better than any other material. With the many different styles of surface finish which can be secured and the various artistic effects possible in coloring it surpasses all other materials for this class of work. A piece of boulevard improvement which has excited considerable comment was the construction of the reinforced

concrete electric light standards along Lincoln Park Boulevard, Chicago. Two hundred and fifty of these have recently been placed. They were designed by Perkins, & Hamilton, Chicago architects and were built in the shops of the Lincoln Park Board. They are surfaced with a veneer of white cement mixed with torpedo sand and red granite screenings. After the cement was sufficiently set, they were carefully brushed with acid to expose the aggregate, thus giving them an appearance much resembling natural cut granite. In general design and artistic proportions they are far superior to the average wood or cast-iron posts. Another rather unusual application of concrete in park improvement is the concrete bench. A great many of them are along the Lake Shore Drive, Chicago. Numerous other examples of artistic effects in concrete may be seen in a short time spent in any of the parks of our larger cities.

CEMENT AND ENGINEERING NEWS

[PUBLISHED MONTHLY]

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue

Cable Address—"Seaferts" Chicago.

Entered at the Post Office at Chicago, as Second-class matter, July 21, 1899 under Act of March 3d, 1879.

Subscription \$2.00 Per Year
Foreign Subscription \$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON Advertising Manager

CHICAGO, APRIL, 1910.

BUILDING REGULATIONS FOR CONCRETE CONSTRUCTION.

What expense of time and money is involved in the preparation of building codes for our large cities has been described in a drastic manner several months ago in the columns of the Engineering News, in which mention was made of the fact that the City of New York spent in round figures \$200,000.00 during the last two years for fees paid to experts for the drawing up of revised building regulations. Yet, in spite of this enormous sum expended the result has been, that all the codes proposed so far have been voted down, so that the lively discussions on many topics will continue for some time until at last a compromise will be reached between the contesting parties.

Other cities are in about the same position as New York with this difference, that they fortunately have not the ample funds to spend for this purpose. The result, however, is quite the same: Engineers and architects in charge of supervising construction work have to dispute their claims with contractors and builders who are naturally antagonistic to municipal supervision and wish to remain as free as possible from restriction. They yield only in the face of the growing number of accidents which from time to time compel the city authorities to become more strict in their methods of protecting the public and to revise or supplement the existing codes.

The struggle between the interested parties becomes especially acute, if new methods of construction are involved which have not withstood the test of many years and consequently are frequently founded on guess-work, or at best can be called experiments. In the latter event, the wise builder will usually double his precautions, whereas the less careful engineer will be prone to take chances. This has been particularly the case in concrete construction, the branch of building which, during the past twenty years, has probably worried the building department of every city the most. In the absence of definite methods of construction and in the expectation of the outcome of long-time tests which were under way, frequently no precautions whatever have been taken and engineers, therefore, had an ample opportunity to experiment and to let the building public or the workman assisting in the construction work suffer with life and limb for the reckless method of designing.

But, not only heedless builders were to blame for the numerous accidents; many of the mishaps during the period of development of concrete construction were due to inexperience in combining steel and concrete for which the fundamental laws had to be established at first. We know now, that in many cases

the calculations of the early designers in concrete were based upon faulty assumptions and that their constructions were, therefore, absolutely unsafe in the light of our present day knowledge.

We certainly have made considerable progress since these first attempts. The principles underlying reinforced concrete construction have been studied with great zeal at almost every experiment station equipped with the proper testing machinery, and a great deal of valuable information on the subject has been brought out by these tests; however, the knowledge gained from year to year plainly indicates that the various methods of uniting steel and concrete have not been sufficiently explored as yet and that methods of construction, which appear safe in the beginning, do not always come up to the expectations under long-time tests. Hence, the utmost precaution is still desired as much as ever before, and a thorough knowledge of steel and concrete and of the laws by which their union is governed becomes especially necessary, when the designer embarks on new adventures of combining the two materials of so widely differing peculiar properties, of which the one is to make good the deficiency of the other. If thus navigating in unknown waters, we have to carefully sound our way and do best to wait for the test of time to demonstrate the safety of the method employed before advising others to adopt our measures. For the building public at large, however, it will always be best to make use exclusively of methods of construction which have been approved and adopted by responsible parties, as for instance the various Governments or building departments.

In this respect the foreign designer in concrete is better guided than we are in this country, since most European countries possess, for a number of years, building regulations which tell what experts in this profession consider safe construction and which, furthermore, prevent the builder from trespassing into the zone of danger. As concrete construction originated in Europe and was widely used there for about twenty years prior to the time when cement began to be manufactured and consumed to any extent in this country, this explains why American countries are about the last to adopt effective methods for regulating reinforced concrete construction. That the few scanty remarks relating to concrete construction to be found in the building codes of the large American cities are absolutely unfit to offer protection has been sufficiently proven by the appalling number of accidents of the past ten years.

The large cities are slow in adopting safe measures and in revising their codes to suit modern conditions. Therefore, engineering societies and men of the profession decide to discuss on their own volition what they consider safe construction and make every effort to have other members of their trade adopt their decisions as standard rules. The difficulties which they encounter in obtaining their ends are almost quite as great as those of the experts employed by municipal governments. They have to engage in endless discussions and finally have to settle their disputes by voting pro or contra certain proposed regulations. The fate of the building public and the outcome of the rules adopted as standards thus depend upon the greater or lesser number of reckless or cautious men who make up the association.

Even less reliable methods of construction must be expected to be voted for, if a similar organization undertaking the preparation of building regulations consists almost entirely of men who are naturally dis-

posed to remain as independent as possible. This undoubtedly is true of the National Association of Cement Users, who, for the second time, discussed their proposed building regulations during the last February meeting in Chicago and who will shortly expect their members to support these rules. As this society, as the name indicates, is largely made up of consumers of cement, we are afraid that building regulations which would really safeguard concrete construction, if proposed by the directors of this body, would be opposed, as the members aiming at the adoption of unrestrained methods will always outnumber the few among them who will advocate safety by all means. However, nothing of this kind has been even attempted by this association. Notwithstanding the fact that in their publications building regulations of other countries are reprinted and discussed, the executive committee of the society submits to their members for letter ballot a code which is a decided step backward compared with foreign regulations for concrete construction, instead of profiting by other countries' experience and offering, if possible, something better. This shows that the men at the head of this society do not even seriously intend to ameliorate the present unsafe conditions or do not realize that the average builder can be compelled to follow the road of safety only, if the building regulations clearly outline safe methods of construction.

These proposed building regulations, for instance, settle by a very few words two of the most important points to which other countries have devoted a great deal of space and, by doing so, have clearly defined the design and obviated disaster as much as possible. We refer to the following passages: "The design must be in accordance with good engineering practice," and "Under no consideration shall forms be removed until the concrete has hardened sufficiently to permit their removal with safety." This much misused word, "good engineering practice," has almost become a standard expression in this country and is quoted at every possible opportunity, but no one has thought it necessary so far, in suggesting building regulations, to stipulate what it means or to define its limits by including examples of design and calculations, as a number of the European specifications do; and, as to the removal of the forms, it appears to us very essential to indicate in which way the time shall be determined when the forms are to be removed. As the American engineer and cement manufacturer, as evidenced by our literature on foreign subjects, realizes more and more every year that the methods adopted by the Association of German Cement Manufacturers and by the German Government are those based on the widest experience and on the safest principles, it occurs to us that we may just as well follow the example of Germany who is going to make the removal of the forms dependent upon the compression strength of test cubes to be made from identically the same concrete as used in the construction work. Thus we share Mr. Goodrich's opinion, who, during the last weeks, pointed out in an article on "The Ideal Specification for Cement," that the best policy to pursue would be to adopt methods prescribed by the German Government.

That "good engineering practice" is a very indefinite term can not be contested by any fair-minded engineer. Many methods of construction go under this definition, which a careful engineer would avoid, and which, though often widely advertised, are of doubtful merits and would not pass the bureau of the building department, if the engineers inspecting the design were familiar with the intrinsic properties of

concrete. A large number of these designs owe their origin simply to the craze of putting new patented systems on the market, which necessarily must include some novel features, no matter whether they are improvements or a step in the opposite direction. The building public, however, is deceived by prominent advertising until the failures become too numerous, in which case other patented systems are devised to replace the former.

Other countries clearly set forth the method of designing and do not let would-be inventors indulge as freely in new patented systems. We may consider this a restriction of our personal privileges, but, upon careful deliberation, must admit that restraint provides more safety than letting the imagination of the average engineer have full sway.

To what exaggerated statements the advertising of such new methods of construction frequently leads could be seen several years ago, when in one of our leading technical journals the standard building regulations of Great Britain were discussed, and when the interpreter found it necessary by the following words to call attention to an entirely novel method of construction which was re-invented in this country and which, in his opinion, was far superior to anything Europe had ever witnessed:

"The methods of calculation, relating to columns, appear to be set forth without knowledge of the most advanced reinforced concrete column design. The Considere type of column alone is considered, with its extremely light longitudinal rods which are considered by some engineers to be actual elements of weakness, although this weakness is supposed to be cured by the wire or other banding. This column can never be satisfactory for use in the highest buildings. The type of column used in the McGraw building in New York, with its self-supporting steel column enveloping the concrete, is admirably adapted to any height of building whatever, and to the strongest and best possible connections for floor beams and girders. Such a column fully justifies 750 pounds per square inch on the concrete instead of 500 pounds stated in the report."

Concrete construction in this country must eventually proceed, or rather retrograde, from bad to worse, if similar advice is given. This steel-frame concrete construction, a method which makes use of angle-irons and a lattice work of flat pieces of iron for columns and similar designs for girders and beams, is neither steel construction nor concrete construction, but a compromise between both.

Similar methods of construction have been tried and have been found to be unsafe in Europe long ago, as concrete does not act in unison with flat pieces of iron, especially if they are set all in a plane, but shrinks away from it, the more so the wetter the concrete and the larger the dimensions of the member. Only to the uninitiated it appears to be a safe method of construction, because it seems to avoid accidents during erection. In fact, steel and concrete act independently from each other, and neither the loose concrete column within the steel-frame nor the steel-frame itself can safely support the load.

Such a column is, at the best, comparable to a spirally reinforced concrete column, in which the spirals have been spaced in a negligent way, in which a number of spirals are close together and in which wide spaces, unprotected by spirals, are between such accumulations of spirals. If some engineers consider the longitudinal rods of Considere's spirally reinforced column "actual elements of weakness," they

certainly do not comprehend what Considere achieved by his invention of spiral reinforcement. The longitudinals in Considere's column merely serve to properly space the spiral reinforcement, unless the designer wishes to decrease the diameter of the column and, for this reason, replaces part of the concrete by an equivalent area of steel, and hence uses more rods or increases their diameters. Thus, as a rule, the designer provides six or eight rods which have not to be very strong, because they have simply to support the spiral during erection. As the longitudinals fulfill no other purpose, it is absolutely unnecessary that "the wire or other banding cures their weakness." The longitudinals in a true spirally reinforced concrete column are not intended to give the column a great deal of strength; they are almost superfluous. The spiral alone is calculated to, and is sufficient to, properly and effectually reinforce the concrete column; and it does reinforce it in a much more reliable way than any number of longitudinal rods, that could possibly be crowded into the circumference of a column, would ever do.

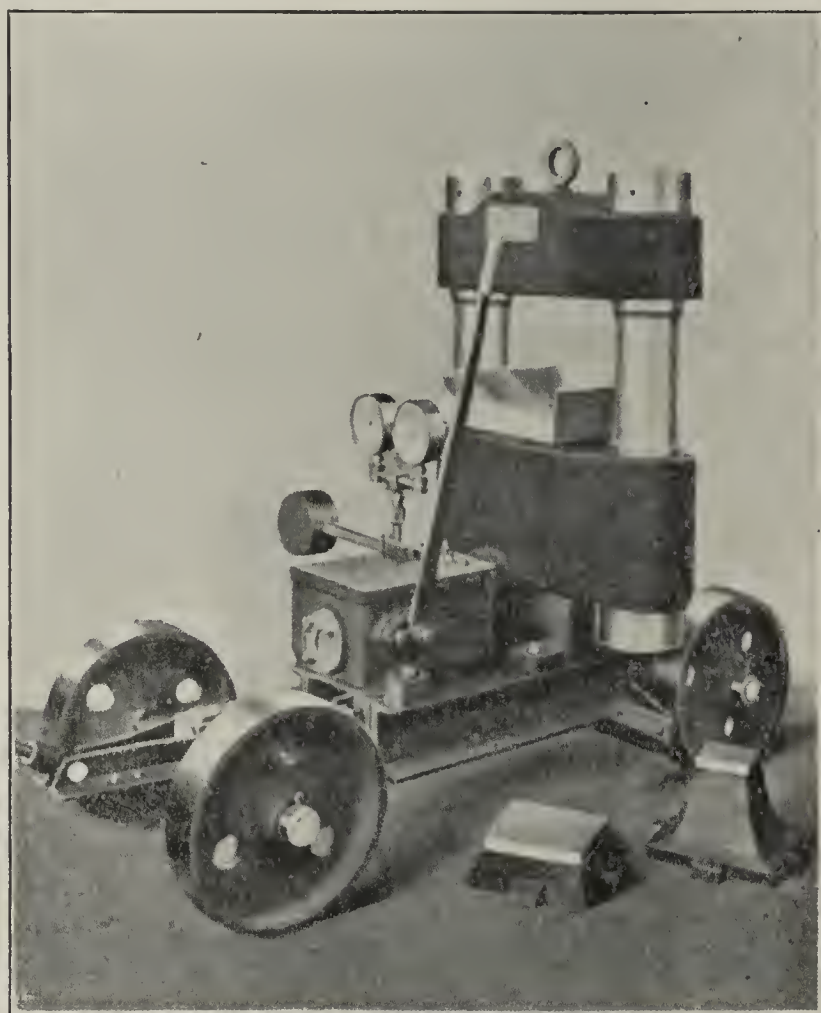
The object of spiral reinforcement is permanent compression of the concrete from all sides, as if it were enclosed in a mould, from the top and the bottom by the load and by the foundation on which the column rests, and by the spiral from all other sides; whereas, in the case of a column with longitudinals only or at a steel-frame concrete column merely a small percentage of the concrete is replaced by steel, so that these columns can withstand but a limited pressure. As soon as this is exceeded, the steel buckles and the concrete gives away in a lateral direction. The spiral reinforcement, on the other hand, takes up only the horizontal component of the pressure, which is about one-third of the vertical pressure, and transforms this into tensile stresses in the steel wire. It solves thus the problem of reinforcing in a very economical and graceful way. Moreover, the spirals are firmly gripped by the concrete, and hence act always in perfect unison with the concrete. Considere's method of spiral reinforcing is the best that has ever been invented and that will ever be invented, and, in fact, we are not in need of anything more perfect. We can not conceive an improvement upon this type of construction. In our opinion, it is the acme of perfection.

The foregoing is a fair example of how far would-be inventors do go in advertising their patented systems and in denouncing methods of construction which have successfully withstood the test of many years and have been adopted as standards by all other countries. This plainly shows the necessity of including methods of design and calculations in the building regulations in the same way as European countries have done.

Furthermore, we fail to see how concrete construction can be carried on safely without making continuous testing of the concrete compulsory in the same way as the German Government has decided to do. All the lengthy debates about how long concrete would have to be allowed to harden in cold weather before removing the forms and all the costly experiments suggested for ascertaining such data would be speedily ended, if every contractor were compelled to make his own tests in each case right on the premises, that is to say, under exactly the same conditions to which the construction work is exposed. Such tests were formerly thought to be impossible on account of expensive machinery being required for crushing the test cubes. Of late, however, also this last objection has been overcome by the manufacture

of very powerful and yet relatively inexpensive portable hydraulic presses of the type illustrated on the accompanying cut, which enable every contractor to take his testing appliances with him from one job to the other.

Besides, test cubes made during the progress of the construction work frequently become effective means of settling disputes between architect and contractor, as alone by continuous testing of the concrete can be decided how soon or late the forms have to be removed. We know, for instance, of cases in which proprietor and architect tried to compel the contractors to remove the forms at an early date and held them responsible for the loss of time involved. Fortunately, the contractors had accompanied their work by continuous testing of six-inch concrete cubes, and were in a position to convince the building department that the concrete had to be given time to harden owing to



unfavorable weather conditions and that, in spite of the declarations of the architect, the concrete was of excellent composition and would attain high strength as soon as warmer weather would set in. Thus the contractors had the building commissioner on their side and were sufficiently protected against the impatient architect and owner of the building. This serves to show that not always the contractor, but often also architect and proprietor are to blame for accidents due to premature removal of the forms.

We hope that the proposed building regulations of the National Association of Cement Users will not be accepted by its members in their present form, and suggest to continue the discussions on the subject until a number of valuable additions are made to the code as outlined in the foregoing. Otherwise, the fate of these specifications will be that they will be of short duration and have to be replaced soon by others in the same way as some of the European codes for concrete construction were found to be insufficient after a brief period and had to be revised. However, with all the valuable experience of European countries ahead of us, there should be nothing in the way of making a success of these specifications from the start without further experimenting and finding out with how little protection we can get along.

PLASTER, OVERBURNT GYPSUM AND HYDRAULIC GYPSUM.

By M. Glasenapp.

An essay, describing the various products obtainable by heating and calcining of native gypsum, based upon an extensive microscopical research, intended to throw light upon the excellent properties of some kinds of burnt gypsum and to end the confusion existing in the classification of gypsum products. Illustrated with numerous photographs of microscopic sections.

Translated by Dr. W. Michaelis, Jr.

(Copyrighted 1910, by William Seafert.)

(Continued from page 100.)

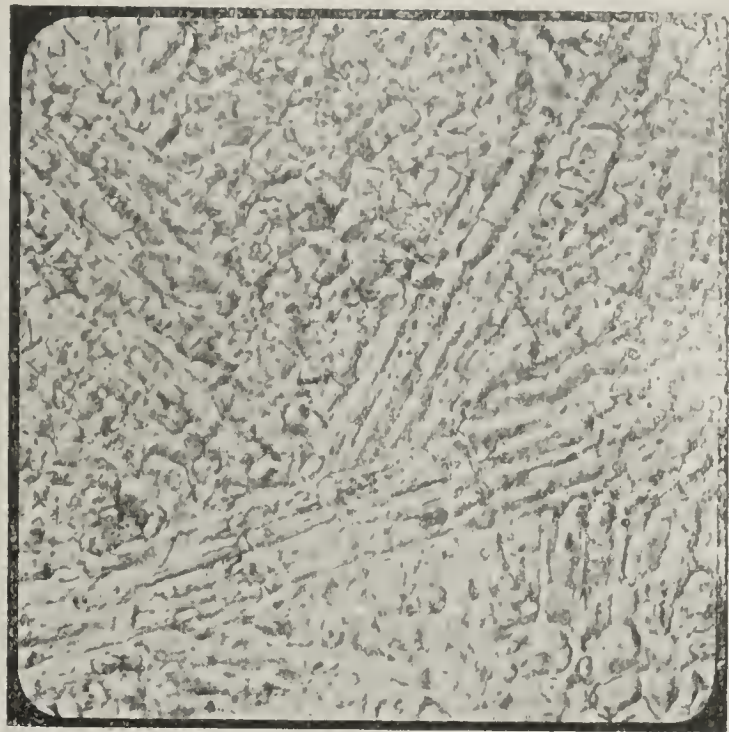
Setting and Hardening of Hydraulic Gypsum:

The statements to be found in the literature on gypsum to the effect that the hardening of hydraulic gypsum was due to the going into solution of the anhydrite and re-crystallizing as di-hydrate from the over-saturated solution, were, as pointed out in the foregoing, based upon observations made on slow-setting plaster and not on hydraulic gypsum. The explanation given was not so incredible, as the hardening process of plaster of Paris could readily be believed to be applicable also to hydraulic gypsum. The slower hardening of the latter was simply attributed to its decreased solubility in water and to its reduced ability to form oversaturated solutions.

However, the observations to be made during the practical application of hydraulic gypsum strongly discredit these views. A hardening process, as that of plaster of Paris, caused by interlacing and growing together of crystals of di-hydrate, appears infeasible in the case of hydraulic gypsum, which requires pounding with wooden mallets and smoothing with trowels after the gypsum has set for a day or two, in order to give it its maximum density and strength. If the hardening were caused by the formation of crystals, a similar treatment would be of no avail, on the contrary it would be highly injurious, because the crystals would be crushed one by another and the cohesion be destroyed. Moreover, it would be inexplicable why hydraulic gypsum possesses far greater hardness and superior strength to plaster of Paris and slowsetting plaster, if the physical and chemical properties of the hardened products were identical, namely the same crystallized di-hydrate.

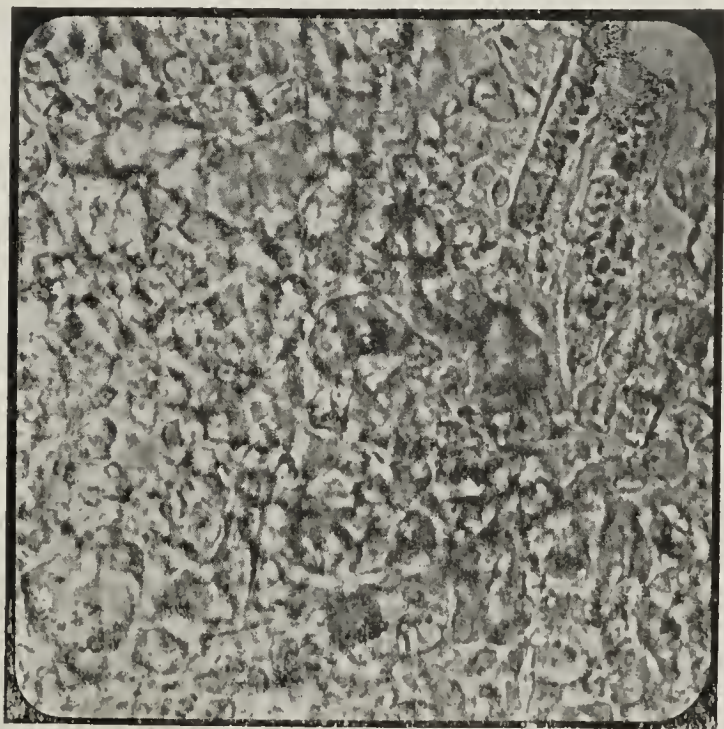
It was mentioned in the foregoing that, according to my observations, powdered hydraulic gypsum placed in water remained, in contrast to plaster of Paris, entirely unchanged for many months and did not show the slightest inclination to form crystals. This observation alone would have been sufficient to suggest a quite different process of hardening; and, in fact, microscopic sections of thoroughly hardened hydraulic gypsum show hardly a trace of crystallization. The component parts of the original calcined product are found unaltered in the hardened gypsum as cuts No. 16 and 17 prove.

Only now and then hollow spaces can be detected partly filled out by crystals of di-hydrate (see cut No. 18). Crystallization, therefore, is of secondary importance in the case of hydraulic gypsum. Hardened pulverized hydraulic gypsum can be distinguished from the unhydrated calcined product only by the more regular alignment of the grains of the latter. But, owing to the fact, that this gypsum is mostly sold as a coarse powder, the hardened gypsum represents in most cases a conglomerate of pieces showing the granular elements in an unchanged position.



No. 16. Section through a hardened piece of hydraulic gypsum showing the unchanged position of its component parts due to the customary coarse grinding. Magnified 750 times.

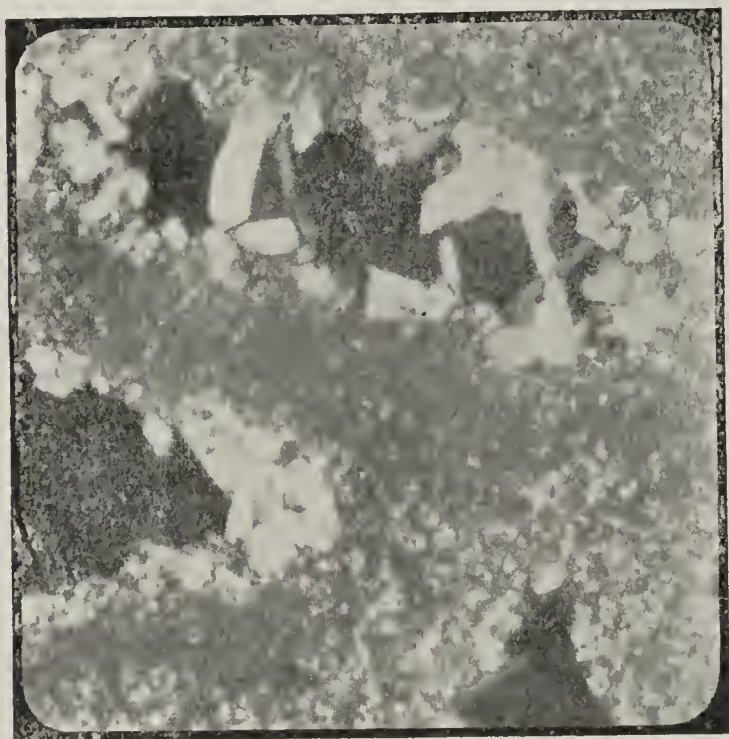
Hence, hydraulic gypsum hydrates principally without changing its form, without crystallizing, because it is unable to form over-saturated solutions. This explains the necessity of densifying the mortar during the early stage of its hardening by tamping it; the particles are thus forced together more closely; hereby the surfaces of contact increase and the grains are cemented more completely. The tamping of the mortar, however, one or two days after hardening has begun, seems to be unavoidable, as the freshly gauged gypsum is too soft to withstand tamping. It would be better, of course, if such a disturbance of the setting process could be avoided; yet, it is of little consequence in as much as, at the time of tamping, the process of hydration is still in its incipency and as only a small amount of water has gone into combination. A determination of the water of combination of a piece of hardening hydraulic gypsum showed 2.18% after 2 days, 5.60% after 14 days and 12.0% after 11 weeks, while about 21% were required for complete transformation into the hydrated state.



No. 17. Section through hardened hydraulic gypsum. In this case the calcined product was ground more finely. The grains, therefore, do not appear in rows, but are isolated and mixed. Magnified 750 times.

This proves the importance of keeping hardening hydraulic gypsum wet for several months, if it is expected to attain its maximum strength. It closely resembles Portland cement in this respect.

While the granular constituent of hydraulic gypsum, the anhydrite, is converted, upon hardening, into di-hydrate without change of form, that is to say without crystallizing, the glassy component may take a share in the hardening in a two-fold manner. In the first place, it is not at all impossible, that its "free" calcium oxide, contained in it in "solid solution," upon coming in contact with water, crystallizes as calcium hydrate. But, this observation I made only in the case of the product calcined in a furnace together with china, which, with its 17% of calcium sulphate and 83% of calcium oxide, represented a very basic glass-like substance. Its powder was acted upon very strongly by water; however, there was no slaking or disintegrating noticeable; the process consisted in a lively formation of small and large plate-crystals of calcium hydrate belonging apparently to the hexagonal system. In the case of commercial hydraulic gypsum, with approximately 3% of "free" calcium oxide, I never observed similar formation of



No. 18. Hollow spaces in a piece of hardened hydraulic gypsum containing a few crystals of di-hydrate. These crystals are due to the evaporation of the water of the saturated (not over-saturated) solution of calcium sulphate that formerly filled out these cavities.

crystals of calcium hydrate upon adding water, nor did I detect them in hardened pieces of hydraulic gypsum.

The second possibility of contributing to the hardening for the "basic calcium sulphate," and which is more likely to be the true explanation, immediately suggested itself by the going into solution of calcium hydrate upon pouring hydraulic gypsum into a large amount of water. The water becomes strongly alkaline after a short time and the surface of it soon appears covered with a thin film consisting of minute calcspar-crystals. This process of going into solution of calcium hydrate and precipitating by the carbonic acid of the atmosphere undoubtedly takes place also during the hardening of hydraulic gypsum as long as "basic calcium sulphate" is available. The process is the same as that causing the hardening of ordinary lime mortar, but of minor importance in the case of hydraulic gypsum. The minute calcspar-crystals can be detected in hardened hydraulic gypsum only by

the development of carbonic acid, if a drop of hydrochloric acid is allowed to act on a microscopic section. After the "free" calcium oxide has been extracted from the "basic calcium sulphate," the remaining neutral calcium sulphate hydrates in the same way as the granular anhydrite, that is to say without forming crystals, as all sections of hardened hydraulic gypsum prove.

The third factor coming in question in the hardening of hydraulic gypsum, and likewise a point of little consequence, is its solubility in water, which lies between that of the half-hydrate and of the di-hydrate and which certainly surpasses that of native gypsum. The small amount of calcium sulphate going into solution may be sufficient to partly or entirely fill out with small crystals of di-hydrate some of the hollow spaces created by the gradual drying out of the hardened gypsum. This feature presents cut No. 18.

A point of greater importance for its technical application is a property characteristic for the grains of hydraulic gypsum, namely that they retain the hardness, which they obtained in the calcining process, also after they have combined with water. This forms the main cause of the strength of hardened hydraulic gypsum. Such strength would be out of the question if the hardening, as assumed so far, would be due to transformation into crystals of di-hydrate.

Influence of Catalysers Upon Hydraulic Gypsum: P. Rohland states that the hardening process of hydraulic gypsum can be accelerated by an admixture of positive catalysers; thus he found the hardening time reduced from 600 to 60 hours by an addition of potassium sulphate. If this were true, it would seem to be of some benefit in the practical application of hydraulic gypsum.

With the aim to throw light on this point I made a series of experiments, especially with potassium aluminum sulphate. These tests prove that hydraulic gypsum, gauged with saturated solutions of alum, precipitates needle-crystals of di-hydrate as early as 15 or 20 minutes after being mixed with the solution. After 2 hours the small grains are completely converted into crystals. After 12 hours about half of it and after 24 or 30 hours almost the whole original mass is crystallized. The process is identically the same as if "overburnt" gypsum is used, which was burnt at temperatures between 300 and 700 centigrade.

The application of accelerating admixtures, therefore, undoubtedly shortens the hardening of hydraulic gypsum, but the hardened product obtained is no longer hydraulic gypsum; it corresponds in every respect with a gypsum burnt at 500 centigrade and subsequently treated with alum solution; owing to the formation of larger crystals, the edges of the hardened mortar are translucent and the whole casting is considerably stronger than hardened plaster of Paris; yet, microscopic examination reveals at a glance, that this is an entirely different hardened product from hydraulic gypsum hardened with pure water.

IV. SUMMARY OF THE RESULTS AND CONCLUSIONS DRAWN FROM THEM WITH REGARD TO PRACTICAL APPLICATION.

By the foregoing observations has been proven that almost all former statements about and concep-

tions of the origin, constitution and properties of hydraulic gypsum to be found in modern literature are erroneous and that this chapter of technology has to be revised completely in order to make it agree with my observations and with the practical experience of the manufacturer. The general opinion that hydraulic gypsum is obtained at temperatures between 400 and 600 centigrade and even still lower has to be positively abandoned. Furthermore, hydraulic gypsum is by no means identical with the soluble anhydrite; it does not show the needle-crystals of di-hydrate as plaster of Paris and the lower grades of "overburnt" gypsum, slow-setting plaster, do. In opposition hereto, the results obtained from my research-work characterize hydraulic gypsum as follows:

Hydraulic gypsum consists of a mixture of a granular, densely vitrified, hard, strongly light-refracting, crystalline modification of the anhydrite, obtained at red heat, with small amounts of a fused, amorphous, glassy, basic anhydrite, containing calcium oxide in "solid solution." This product requires for its formation and for the complete development of its constituents a temperature of about 900 centigrade. At higher temperatures, at 1300 centigrade and above, the amount of the basic constituent increases and the grains grow in size and hardness. It combines with water without change of shape, that is to say without forming crystals, with the exception of very small amounts of crystallized di-hydrate and calcium hydrate, and retains its optic properties and hardness. Positive catalysers, however, transform it into soluble anhydrite and crystals of di-hydrate.

For the practical gypsum burner the most important and noteworthy point is this, that it is almost out of the question to spoil a charge by overburning. The heat may be increased to 1300 centigrade and even higher, but not for too long a time, without impairing the hardening properties, providing the fire is conducted in such a way that the gypsum is not reduced to calcium sulphide. On the other hand, the temperature may go down as low as 800 centigrade; however, it will always be advisable to regard 900 centigrade as the lowest limit, because only then the characteristic hard-sintered grain is formed. The wide interval of from 400 to 500 degrees, within which the heat in the kiln may vary, makes the burning process very convenient and safe. Heating above 1000 centigrade is not economical, of course; yet, I wish to repeat at this place, that at very high temperatures, between 1300 and 1400 centigrade—at least in laboratory experiments—a still coarser and apparently even harder, because more strongly sintered, grain is obtained, which may possibly be of value for some purposes. But as not only the height of the temperature, but also its duration, governs the physical properties of the grain, the same effect is likely to be obtained also at lower temperatures in practical operation.

By my research has been demonstrated, from a scientific standpoint, that hydraulic gypsum represents the product differing in every respect from plaster of Paris and slow-setting plaster, which the manufacturer claimed to be the case for some time. It is a more precious substance, the superior qualities of which are certainly not sufficiently appreciated as yet by the building trade. For many years, for instance, vain efforts have been made to produce a white cement, until at last a number of factories succeeded in turning out a fairly satisfactory but expen-

sive product. Hydraulic gypsum is a white cement of the highest order. On account of its excellent hydraulic properties, being fully equal to those of Portland cement, and because of its dense structure, which minimizes the danger of soiling of the surface, this cement is surely superior to white Portland cement and should be used more extensively.

Among other uses, it would be advisable, for instance, to try hydraulic gypsum for castings of plastic works of art and of architectural decorations. To this suggestion the objection may be made that hydraulic gypsum is mostly too coarsely ground for this purpose and that it is heavier than plaster; moreover, that it does not set as rapidly. There is nothing in the way of grinding it more finely; on the contrary, this would be an easy matter, as the calcined gypsum shows a natural inclination of breaking up into the minute grains composing it. The tamping of such castings, a day or two after having been poured into the moulds, would have to be avoided most likely. Therefore, another method would have to be employed in order to provide greatest possible density. This could be achieved by mixing two kinds of hydraulic gypsum burnt at different temperatures and ground to different fineness, for instance, coarsely ground hydraulic gypsum burnt between 1200 and 1300 centigrade, with its large granular elements, and finely ground hydraulic gypsum calcined at about 800 centigrade. The minute grains of the latter would fill out all voids between the grains of the former. Such a process of mixing would be based upon the experience, that the size of the granular constituents of hydraulic gypsum grows with increased heat and would soon lead to a mixture possessing the greatest possible weight for a given volume. Experiments made in this direction showed a weight of 149 grams per 100 ccm. of hydraulic gypsum passing a 100-mesh sieve and of 190 grams for the same volume of hydraulic gypsum passing the 200-mesh sieve. Of the various mixtures made from these two screenings that showed the highest weight per given volume (100 ccm.), namely 203 grams, which contained 40% of the coarse and 60% of the fine product. For this test only one kind of hydraulic gypsum was used possessing granular elements of almost even size. If two products of widely differing burning temperature would have been used, a still higher weight by volume would have been obtained undoubtedly.

The slow progress made in the hardening of such castings would be a drawback, of course; yet, their strength after a few days is sufficient to allow taking them out of the moulds. Afterwards they have merely to be kept in a chamber saturated with moisture and to be sprinkled with water now and then in order not to interrupt the hardening process by drying out of the castings. If the moulds have to be used again very soon, the hardening of hydraulic gypsum may be accelerated by small admixtures (about 10% of its weight) of slow-setting plaster, burnt between 200 and 220 centigrade. A similar plaster hardens more slowly than ordinary plaster of Paris, but sets sufficiently fast and has this advantage over the latter, that it forms larger crystals of di-hydrate. On the other hand, the strength and durability of plaster of Paris could be improved by an admixture of hydraulic gypsum.

Microscopic Determination of the Commercial Products of Gypsum: On account of the present uncertainty, or even confusion, prevailing in the definition of hydraulic gypsum and on account of its frequent

being mistaken for the slow-setting "soluble" or first anhydrite (burnt between 200 and 350 centigrade) and even for plaster of Paris, a simple, reliable and brief determination of the various products manufactured from native gypsum would certainly be desirable and of great value. The microscopical examination enables the investigator to attain this end speedily and safely. Genuine hydraulic gypsum, that is to say gypsum calcined at a temperature of at least 900 centigrade, can be easily distinguished through it from all other kinds of burnt gypsum and also from powdered raw gypsum, so that this method should be employed in all doubtful cases. A similar investigation requires but a few minutes. A trace of the powder to be examined is stirred with a drop of water on a microscopic slide and a cover glass is placed upon it. Then the cover glass is subjected to a slight pressure in order to disintegrate the coarser grains and to make the conglomerations of the granular constituents of hydraulic gypsum separate into their elements, grains or plates or whatever the case may be. The preparation should be magnified 300 or 400 times; but even 200-fold magnification suffices in most instances.

In analyzing the fragments to be observed under the microscope the following must be borne in mind: All particles of fibrous and translucent appearance and those of a yellowish-brown color are burnt below 800 centigrade and have nothing in common with hydraulic gypsum. They have the shape of prongs, spikes or splinters and contain numerous needle-shaped fragments deriving from the crystallized fibers of the original raw gypsum. Cut No. 11 and No. 8 illustrate these fragments. In opposition hereto, the microscopic elements of hydraulic gypsum show not the least sign of a fibrous structure (with the exception of that burnt at 800 centigrade, the temperature at which the formation of hydraulic gypsum begins). They are entirely clear and transparent in almost every instance and, owing to their strong light-refraction, appear lighter than the surrounding water. The grains and rows of granular elements possess forms so characteristic (as cut No. 10 and No. 12-17 show), that a particle of hydraulic gypsum, which happens to be in plaster of Paris, is detected at a glance. Needle-crystals or fragments of them do not occur in hydraulic gypsum burnt at 900 centigrade and above, so that the absence of them is a sure sign of genuine hydraulic gypsum. Another characteristic for hydraulic gypsum are the minute holes often found in the granular elements. In polarized light the particles of hydraulic gypsum can be readily distinguished from all kinds of gypsum burnt below 800 centigrade by their remarkably strong iridescence.

The microscope, however, furnishes still further information about hydraulic gypsum. It permits to determine approximately its burning temperature on account of the growing size of its constituents with rising temperatures. Large grains indicate a high burning temperature, while rectangular plates (see cut No. 15) or fragments of them prove that the product was calcined at a temperature slightly below its fusing point. In connection with these views, presented by the microscope, it must be remembered that the hardness of the grain and consequently the strength of the resulting mortar grow with the size of the granular component of hydraulic gypsum.

Plaster of Paris can be distinguished from the slow-setting I. anhydrite by the time when crystallisation of di-hydrate begins. The exterior shape of their particles offers no marks of distinction.

In conclusion the various calcined products obtainable from raw gypsum may be classified in accordance with the results derived from the foregoing research. The limits of temperatures stated must only be considered as approximate figures, of course, as the change from one kind to the other takes place very gradually and because, as repeatedly stated, not only the height of the temperature, but also its duration, determine the properties of the calcined product:

- | | | |
|---|----------------|---|
| A. | Native Gypsum— | Di-hydrate, containing 2 molecules of water. |
| B. | 107 | Celsius—Half-hydrate, containing $\frac{1}{2}$ mol. of water. |
| C. | 107-170 | " —Consists mainly of half-hydrate. |
| D. | 170-200 | " —More or less dehydrated half-hydrate. Combines with water readily until half-hydrate is obtained. |
| C. & D. represent the commercial plaster of Paris. | | |
| E. | 200-250 | " —Contains a very small amount of water. Sets more slowly than the former. |
| F. | 250-400 | " —Contains only a trace of water. Slow-setting. |
| B., C., D., E. & F. form crystals of di-hydrate, if mixed with water. Hardening due to crystallization. | | |
| G. | 400-750 | " —Completely dehydrated, anhydrite, over-burnt from a practical point of view. |
| H. | 750-800 | " —Gradual transformation into the granular modification of anhydrite; beginning of the formation of hydraulic gypsum. |
| G. & H. Show, in contact with water, no hardening or only very imperfect hardening. | | |
| I. | 800 | " —Hydraulic gypsum, containing minute grains of anhydrite. |
| K. | 900-1000 | " —Genuine hydraulic gypsum; grains fully developed. |
| L. | 1000-1400 | " —Hydraulic gypsum, showing grains increasing in size and hardness with rising temperature. The percentage of "basic calcium sulphate" likewise increases in the same ratio. |
| I., K. & L., harden slowly with water without crystallizing. | | |
| G., H., I., K., & L. crystallize with alum solution. | | |

A temperature of from 1300 to 1400 centigrade, in my opinion, can be employed in the manufacture of hydraulic gypsum only in cases, in which the gypsum does not come in immediate contact with the fuel, as, for instance, in laboratory experiments, in which the burning is done with gas. Where coal is used, the ashes of it as well as the reducing carbon are bound to contaminate and spoil the calcined product. Moreover, temperatures as high as these are almost out of the question in practical operation.

A NEW MACHINE FOR RAW MATERIAL.

The accompanying cut illustrates the New Williams Raw Material grinder, for Tube Mill Feed.

The latest addition to the Williams Hammer Mills is a Universal Grinder 60" in diameter, operating at 720 R. P. M.

This extra large unit is of especial interest to large Cement Manufacturers where large units are desired.

This 60" machine which is the No. 9 size is equipped with Automatic feeder driven from mill shaft, with their celebrated grinding plate, adjustable hammers, safety device or metal arrestor to relieve machine quickly of foreign material, special milled tool steel cage bars, absolute uniform openings, and many other improvements too numerous to mention.

This No. 9 will take Limestone, Bluestone, Shale, Clay, or Coal, in cubes $1\frac{1}{2}$ " and under, and deliver to Tube Mill a product of 95% through 20 mesh, without screens or separators.. This No. 9 unit will handle from 18 to 25 tons of Raw Mix hourly, depending upon the grindability of the rock. This machine will do the work of five (5) Ball Mills and double the work of the largest units now commonly used in the Cement Plants.



Interior View.

The Universal Portland Cement Co., Universal, Pa., have installed five (5) of these No. 9's and have just ordered four (4) more for the South Chicago and Buffington operations.

We also have installed three (3) more in smaller companies who recognize the economy in a unit of this size. We have proven beyond any question of doubt that these mills will give a uniform product year in and year out by the adjustment of our grinding plate from the outside of the machine, while in operation, and that the cost of maintenance is much less than any other machine for this work, and that the Horse Power per barrel is at least 50% less than other methods now in use.

The first No. 9 has now been in operation some thirteen (13) months and is giving the same excellent results today that it gave on the day it was started. This same machine is made in a smaller unit of 8 to 10 tons hourly for the average Portland Cement plant, and contains all of the improvements of the larger machine.

The Williams Company make a specialty of preparing Raw Material "only" for Tube Mills and Roller Mills, and have just issued some interesting literature on their mills for Cement Mill work.

Address The William Patent Crusher & Pulverizer Co., 545 Old Colony Building, Chicago, Ill.

WEBSTER CO. LANDS BIG CONTRACT.

The Webster Mfg. Co., Chicago, Ill., have been awarded the contract to furnish the following equipment for the new plant of the Clinchfield Portland Cement Company, at Kingsport, Tenn., viz.: Power Transmission Machinery, Elevating Machinery, Conveying machinery.

The Clinchfield cement mill will be modern in every detail. The engineers have taken advantage of all the latest and best mechanical devices for turning out a product of the highest quality.

SELL CHANUTE CEMENT CO., AT PUBLIC SALE.

Erie, Kan.,—Ex-State Auditor Seth G. Wells, receiver of the Chanute Cement and Clay Product Company which went into bankruptcy several months ago, announces that he will sell the entire plant at Chanute at public sale on April 15. The appraised value of the property is \$233,861 and Judge Pollock of the United States district court has placed an upset price of \$75,000 upon it.

HUNT ENGINEERING MOVES.

The headquarters of the Hunt Engineering Company at Iola, Kan., have been moved to Kansas City, Mo. They are now located at 911 Commerce building. This well-known company have a number of contracts on hand for the erection of cement manufacturing plants.

ROBINS CONVEYING BELT COMPANY REMOVE THEIR EXECUTIVE OFFICES.

The Robins Conveying Belt Company announce that arrangements have been made for the removal of their executive offices and sales, engineering and purchasing departments to the twenty-seventh floors and both towers of the Park Row Building, 13 Park Row, New York. Their occupancy of the new quarters will be completed by April 15th. This suite is the one occupied by them up to two years ago, when their general offices were removed to their works at Passaic, New Jersey, and a branch office opened in the Terminal Buildings, at 30 Church Street, New York. The office at the Church Street address will now be discontinued and combined with their other offices in the Park Row Building.

THE CONSTRUCTION OF THE RAINBOW FALLS HYDROELECTRIC DEVELOPMENT.

The Great Falls Water Power & Townsite Company, of Great Falls, Mont., has under construction a hydroelectric development on the Missouri River, a short distance below that city, which will utilize a total head of about 108 ft. and embrace generating equipment having a normal rated capacity of 21,000

than six miles. The downstream one of these cascades is known as the Great Falls, which have a height of 80 ft. The next one, $3\frac{1}{2}$ miles upstream, is Crooked Falls, with a drop of 19 ft. About 1600 ft. above Crooked Falls are the Rainbow Falls, having a sheer drop of 47 ft. 8 in. The fourth one of the series, Coulter's Falls, is 1500 ft. upstream from Rainbow Falls, the difference in elevation of the pools above and below it being 14 ft. 7 in. Black Eagle Falls, the upstream one of the series, is about 2 miles above



Concrete Headgates at Rainbow Dam. Iola Portland Cement used on this Work.

kw. This development is a part of the system of that company; forming one of the most comprehensive power projects of the kind in this country. The cities of Great Falls, Butte, Anaconda, Billings and Helena are reached by the transmission lines connecting the various plants of the system, but the bulk of the power will be delivered to the Butte mining district.

The Great Falls in the Missouri River comprise five distinct cascades, with rapids between them, the total drop being almost exactly 400 ft. in a distance of less

Rainbow Falls, and has a drop of 26 ft. 5 in. In addition to the abrupt breaks at these five falls, the bed of the river is on a steep slope, between them thus producing the total difference in elevation of 400 ft. in a comparatively short distance.

A rock-filled timber-crib dam, built across the river directly above Black Eagle Falls in 1900-1901 by the Great Falls Water Power & Townsite Company, develops a head of 44 ft. that is utilized, in the power house in connection with it. The equipment of this



Rock Filling at Rainbow Dam. Dump Cars used on this Work Made by Western Wheeled Scraper Co., Aurora, Ill.

power house has a rated capacity of approximately 9000 kw., of which 7000 kw. is required in the operation of the adjacent smelter of the Boston & Montana Consolidated Mining Company. This development will, however, be connected with the generating system of the Great Falls Water Power & Townsite Company.

The preparation of the plans for works to utilize the fall in the river below the Black Eagle dam was started early in 1908. These plans contemplate the hydraulic development at Rainbow Falls, and one of almost exactly the same capacity at Great Falls. The former development will render available the total drop in Rainbow Falls, Crooked Falls and a part of that in Coulter's Falls, together with rapids between these cascades. The development at Great Falls will utilize the sheer drop of the latter and rapids above and be-

Falls, with the intervening rapids, is made available by the penstocks, giving an effective head of 108 ft. at the power house.

The average low-water flow of the river at the dam is estimated from available records to be 3100 cu. ft. per second, and the normal maximum volume of discharge to be 40,000 cu. ft. per second. The extreme minimum may be expected to reach 2100 cu. ft. per second, while a flood of 120,000 cu. ft. per second occurred in June, 1908, but this freshet stage was far above any previous known records. The high water usually begins each year about the middle of May, when the snow in the mountains at the headwaters of the river starts to melt, and continues to rise until the peak is reached, between the middle and the last of June. The volume of flow then drops off quickly in ordinary years to about 8000 to 10,000 cu. ft. per



Waste Gates at Rainbow Falls Dams, Great Falls, Montana. View of the Spillway from West-end of Dam.

low this drop. The construction of the Rainbow Falls development was started in September, 1908, and has been prosecuted continuously since then with all possible speed. Considerable preliminary work also has been done at the site of the Great Falls development, but the principal construction features of the latter are only started.

The Rainbow Falls development embraces essentially a rock-filled timber-crib dam, directly above those falls, which diverts a flow into two steel penstocks leading from the left-hand or east end of this dam to the forebay of a power house 2400 ft. downstream from the end of the crest of Coulter's Falls, on that side of the river. The spillway crest of the dam, 1145 ft. in length, is 25 ft. above the low-water stage of the river at the site, while flashboards will permit the pool level determined by it to be raised 4 ft. In addition to the head of 29 ft. thus developed, the combined drop of the Rainbow and the Crooked

second by the middle of July, and 4500 to 6000 cu. ft. per second by the first of August. Following the latter date, the decline is gradual, the minimum being reached in the winter. The construction work accordingly had to be conducted so the tremendous flood flows might be passed across the site without interference and with ample provisions for handling the comparatively large volume of water during the balance of the year.

The rock-filled timber-crib dam contains approximately 5,000,000 board feet of lumber, 5500 cu. yd. of concrete, and 30,000 cu. yard. of stone ballast, making it one of the largest dams of this type that has been built. At the right-hand end of the spillway and against the rock bank of the river is a massive waste-gate structure of concrete, containing five 8 x 10-ft. openings. From this structure to the opposite bank of the spillway and apron section of the dam are continuous, an angle being introduced at about the

middle of their length of 1145 ft. At the left-hand end of the dam is a heavy concrete abutment extending to a height of 12 ft. above the crest of the spillway. Immediately upstream from this abutment, and in connection with the latter, are the concrete head-works of the penstocks, these works being built into the river bank.

The penstocks consist of two 15.5-ft. riveted-steel tubes, both 2400 ft. long, which are laid together in the same trench. They are on a 0.21 per cent grade, and terminate in a regulating basin covering an area of about $1\frac{1}{2}$ acres at the crest of the high bank of the river in the rear of the power house. Three sides of this basin will be formed by tall concrete walls, while the shore side is to be the slope of the excavation that was required in constructing the basin, about 60,000 cu. yd. having been moved to prepare the site.

Twelve steel penstocks, each 8 ft. in diameter, will extend from the concrete head-wall on the stream side of the regulating basin to the power house at the base of the river bank, directly below it. The power house will stand on solid rock in a section of the bed of the river unwatered directly below the end of Crooked Falls, by means of a shear dam extending out from the bank at the latter. The building, 82x334 ft. in plan, is to have a concrete substructure carrying a structural-steel frame enclosed by curtain walls of brick. The draft tubes of six pairs of wheels installed will discharge into a tail-race, 60 ft. wide, that is excavated to a depth of 26 ft. at the power house. The tail-race extends downstream about 1000 ft. parallel with the channel to the point where its grade and that of the river come together.

The foundation of the dam, including the waste-gate structure and the head-works of the penstocks, is a dense sandstone bedrock, having an unbroken surface marked only by water-worn depressions. The excellent character of this rock may be judged from the fact that no evident erosion has occurred in the 104 years which have elapsed since the first accurate surveys of the crests of the falls were made by the Lewis and Clark Expedition. The various features of the dam are anchored to the bedrock either by means of cut-off trenches excavated into it under the concrete structures, or by bolts grouted into holes bored vertically into it.

The spillway and apron section of the dam is 115 ft. wide at the base, the slope of the face of the apron being varied according to the shape of the rock surface. The lowest course of the framework of the dam consists of 12 x 12-in. stringers, spaced 8 ft. apart on centers, normal to the axis of the structure. The foundation for these timbers was prepared by cutting through the high points of the rock and by filling the depressions in the surface of the latter with concrete, advantage being taken of the irregularities to assist in holding the dam in place. The timbers were generally in 16-ft. length, laid with broken joints, each length of timber being anchored by two $1\frac{3}{4}$ -in. steel pins, 42 or 48 in. long, grouted into the holes drilled in the rock. The timbers in the spillway section of the dam, all of 12 x 12-in. size, are spaced 8 ft. apart on centers parallel with the axis of the dam, and 8 ft. apart normal to it. They are framed so the thrust on the foundation is normal to the upstream face of the structure. Each course of timbers is attached to the one below it at every intersection by $\frac{7}{8}$ -in. drift bolts, which are 28 in. long, so that each bolt engages three courses of the frame. The pockets of the crib are filled closely with rock, consisting of the run of the quarry, with one-man stone as a maximum size. The pocket

at the upstream toe of the dam is filled with concrete, and the pond side of this pocket is faced with 6-in. splined plank, ship-nailed to the timbers of the crib. On the water side of the base of the row of vertical plank is also a fillet of concrete placed to seal the dam and to anchor the plank in position.

The tops of the pocket on the upstream face of the dam are covered with a heavy deck, designed to make the structure watertight and to prevent the displacement of the rock ballast. A course of 12 x 12-in. timbers laid parallel with the axis of the dam was first placed over the tops of the pockets and drift-bolted to the timbers in both directions, forming the sides of the latter. These 12 x 12-in. timbers were laid to form a tight deck, except adjacent to the middle of the face, where it was practicable to leave 3 and 4-in. spaces between them. A course of 8 x 12-in. splined stuff, laid close together and at right-angles to the timbers of the frame, was drift-bolted to the deck of 12 x 12-in. timbers the full width of the upstream face of the spillway. The tight covering thus formed was sheeted in turn with 4 x 12 in. splined plank, nailed to it in the opposite directions. These three courses of decking are joined with a row of sheeting at the toe of the dam, so no obstruction is presented on the surface of the latter. To protect the deck against damage from ice, it is shod for a width of 12 ft. down from the crest with $\frac{5}{16}$ -in. steel plates, spiked to the upper two courses by means of 10-in. ship nails.

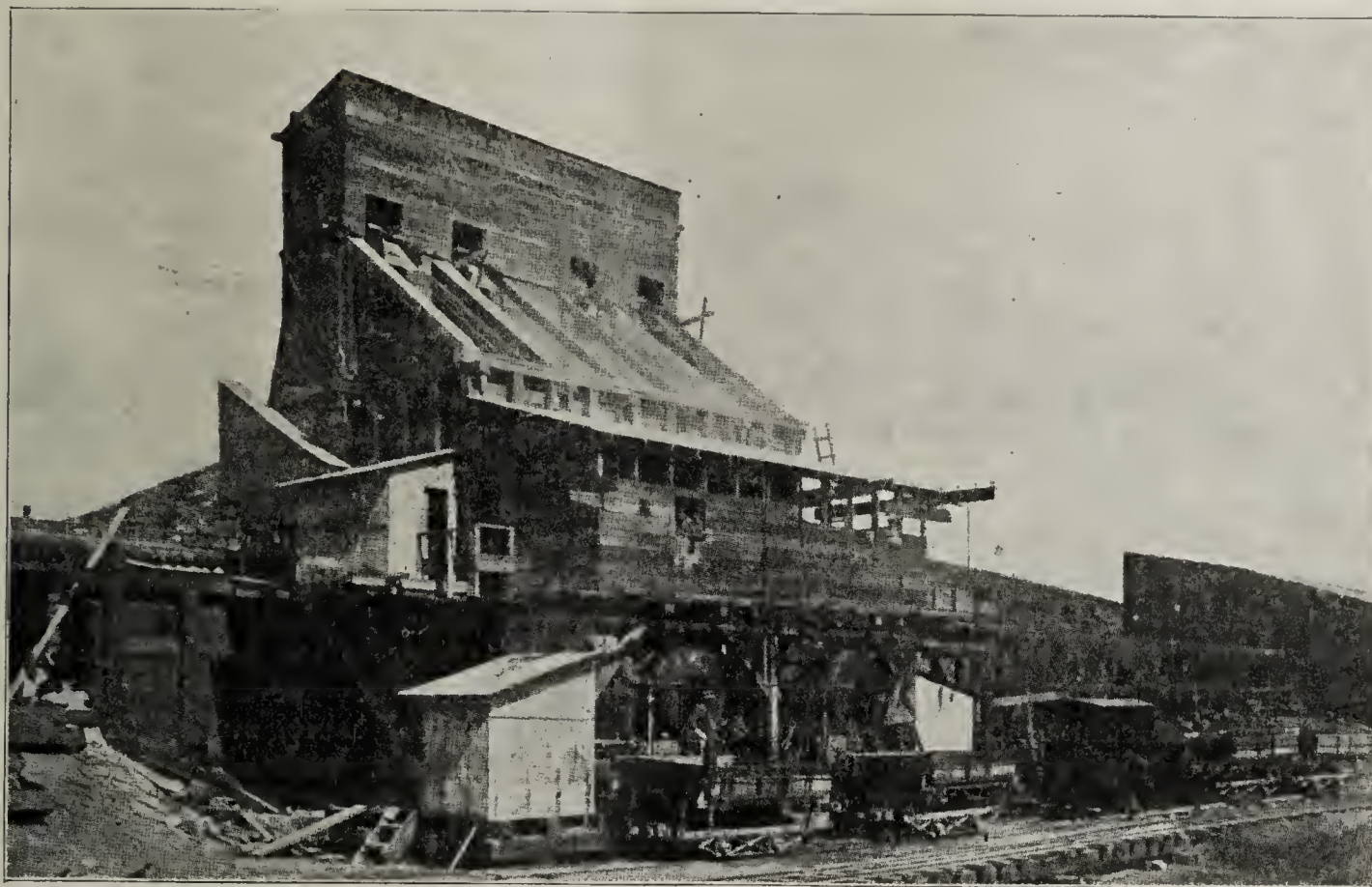
The downstream side of the spillway is on a slope of 8 in. to the foot for a horizontal distance of 30.5 ft. to its connection with the surface of the apron. The latter is 49 ft. in width, and has a slope varying with the irregularities in the surface of the bed rock of the river. The 2 on 3 slope of the spillway is formed by 12 x 14-in. timbers laid parallel with the axis of the dam and framed to receive a tight deck of 8 x 12-in. splined timbers drift-bolted to them in the opposite direction. The pockets of the crib forming the apron are filled with concrete containing some large plum stones. The apron is covered with a deck of 12 x 12-in. timbers, laid solid and normal to the axis of the dam, and drift-bolted to the crib timbers. For a width of 12 ft. along the upstream side of the apron, the deck of the latter is protected by $\frac{5}{16}$ -in. steel plates against damage from ice passing over the crest. These extend back under the ends of the 8x12-in. timbers on the face of the spillway at the junction of the slope of the latter with that of the apron. This arrangement protects the ends of the plates from being torn loose, and the resultant liability of the removal of any section of the covering that might otherwise be loosened in this manner.

Field operations were started in September, 1908, by extending to the right-hand end of the dam a branch track from an adjacent line of the Great Northern Railway. This line crosses the river directly above the dam on a four-span truss deck bridge at an elevation of about 90 ft. above the original low-water level. The branch leaves the main track near the regulating basin of the development, half a mile beyond the bridge. It swings from this point around the edge of the hill and upstream to the construction power plant and timber storage yards, adjacent to the left-hand end of the dam and close to the corresponding end of the bridge, but at an elevation 60 ft. below the track on the latter. All of the construction materials and supplies are delivered over this branch track in the standard gauge cars in which they are shipped, thus greatly facilitating operations.

The temporary power house installed in connection with the work is on the downhill side of the branch track, and contains a boiler and an engine room. In the former room are two 250-hp. boilers, operating under 100 lb. steam pressure. The branch track is on a trestle 15 ft. above the firing floor in front of the boilers. The coal supply for the latter can be delivered from bottom-dump cars to bins against the

which the lines of pipe are moved being specially advantageous.

A concrete mixing plant is erected at the same level as the power house, and 300 ft. upstream from the latter. The crushed limestone used for the 40,000 cu. yd. of concrete involved in the project is obtained from a quarry 40 miles distant, and shipped by rail directly to the plant in 80,000-lb. bottom-dump steel



The Concrete Mixing Plant Near the Headworks. Koehring Concrete Mixers Discharging Concrete in Western Dump Cars.

side of the building and shoveled by hand from these bins directly to the boilers. The engine room contains a 19 x 32 x 48-in. Gates Corliss cross-compound engine, belted to a 250-kw., direct-current, 550-volt generator and a straight-line, two-stage air compressor, delivering against a pressure of 80 to 100 lb. per square inch. The generator furnishes power for lights and to

ore cars. The sand for the concrete is produced at the smelter $1\frac{1}{2}$ miles above the dam and also is shipped in the same type of cars. The branch track extends along the uphill side of the concrete plant on a trestle, so the sand and crushed stone may be dumped by gravity from the cars into the hoppers at the ground level. Four bucket elevators driven in pairs by 15-hp. motors



Great Falls Water Power and Townsite Co. View of Regulating Reservoir, and Steel Riveted Penstocks.

motors driving various features of the construction plant. Air is delivered from the power house by 6 and 8-in. spiral-riveted pipe lines extending to different points on the work where pneumatic tools are used. The spiral riveted pipe was employed because the low freight charges on it offset its greater cost as compared with that of other types. At the same time, it has been very satisfactory in service, the ease with

hoist the materials from these bins to a height of 42 ft. above the ground, and discharge them into storage bins at the top of the building. Three storage bins are provided, one at the middle for the crushed stone, and one at each end for sand.

In front of the bottom of the storage bins is a measuring and charging platform over the two 1-yd. Koehring mixers installed. The Iola Portland cement

used is delivered by rail to a storage house that also faces on the branch track. A trestle extending from this house to the concrete plant, carries a narrow-gauge track over which the cement is delivered as required to the measuring floor. A hopper over each mixer is arranged with a partition so the proportions of materials may be adjusted as the latter are delivered through chutes from the storage bins. The cement then is added, just before the batch is dropped into the mixer, by means of a gate operated by a lever extending above the measuring floor. The water for each batch is measured in a barrel, to which it is delivered through a quick-opening valve on a 3-in. pipe line, and from which it is drawn in a similar manner.

The two mixers are set high enough to discharge into 4-yd. dump cars on a track in front of the plant. Each mixer is separately belt-driven by a 15-hp. motor, housed in a tight shed adjacent to it. A system of narrow-gauge service tracks has been extended to various parts of the work, so the concrete may be hauled in the 4-yd. dump cars by 10-ton locomotives to the point where operations are in progress. The head-works of the penstocks in the adjacent abutment of the dam were so close to the concrete plant, however, that it was more satisfactory to handle the concrete for them in 1-yd. cars, which were pulled up an incline by a hoist and were then shunted to place over a track laid on the forms.

Work in the river was commenced in September, 1908, as soon as the flood stage of that year had begun to recede to the normal flow. A low shear dam was first started out from the left bank of the river at a point several hundred feet upstream from the corresponding end of the crest of Coulter's Falls. This dam was continued inshore at an average angle of about 30 degrees downstream, until it reached the crest of those falls. It was advanced from the shore at a height of about 7 ft. above the normal stage of the river, in water 3 to 8 ft. deep, by end-dumping from wheelbarrows rock quarried from the river bank. As soon as this dam, which reached a length of 400 ft., was finished, it unwatered the crest of Coulter's Falls for 200 ft. from the shore. The construction of a second shear dam, extending downstream from the crest of those falls and generally parallel with the channel of the river, could then proceed. This second dam was built by end-dumping quarried rock, the same as in the case of the first one. When it had been continued 950 ft., bringing it within 200 ft. of the crest of Rainbow Falls, the hydraulic grade of the rapids above the latter was sufficient to reduce the depth of water and to completely break the current behind it.

A permanent submerged-crib dam extends upstream from a point on the spillway about 250 ft. from the waste-gate structure of the latter, and at a slight angle with the channel, to the shore on the opposite side. The crest of the main dam is 15 ft. above that of this permanent crib dam, the latter being provided to intercept sand that is carried in large quantities by the river. The submerged dam is built of 16x 16-ft. rock-filled timber cribs placed abutting, and closed on the stream side with a tight wall of triple-lap sheeting. A seal of clay also was dumped along the toe of the sheeting to cut off any flow under the cribs during construction.

The submerged-crib dam was advanced from the shore end, in order that a track for work trains could be laid on top of it to deliver the materials required. When it had been continued downstream to a point about 300 ft. above the site of the main dam, the

placing of cribs in the channel to carry a track across to the waste-gate structure, was started. These cribs, 16 x 16 ft. in plan, and 12 to 18 ft. high, had to be set in 5 to 8 ft. of water, flowing at a velocity of 6 to 10 ft. a second. It also was desired to anchor them so they would not be carried out by high water, even though the restriction of the channel by them increased the velocity of the current greatly.

To meet these conditions, the cribs were built cob-house fashion in the usual manner, except that a closure grid was added at the bottom to hold the stone ballast. This grid was placed in the second course of timbers above the bottom, and consisted of 12 x 12-in. pieces, spaced 3 ft. apart on centers. Arranged in this manner, it prevented the stone ballast used in anchoring the crib from resting entirely on the bottom of the river, thus permitting the weight of the ballast to be utilized to the best advantage in holding the walls of the crib on the rock. Movement of the cribs also was prevented by driving sharpened bolts through the timbers in the lowest course of the walls so they projected as spurs that sank into the bed rock of the river when the weight of the crib and its ballast came on them.

Nine of the cribs constructed according to this plan were set across the channel, with intervals between them of from 16 to 25 ft. The cribs were launched into the river, after being properly framed on the bank. Then they were lashed to a block and fall on a 1½-in. steel cable, strung across the channel, and by means of the latter they were located without difficulty and the ballast placed in them. During the high water of the past season the flow in the river reached 45,000 cu. ft. per second, nearly submerging the cribs in 15 to 18 ft. of water flowing at a high velocity. In fact, the current was so swift that a drop of 6 or 7 ft. occurred in the width of the cribs near the center of the channel. Even under these conditions, however, none of them were moved.

As soon as the cribs were placed in the channel a track was laid on them in March, 1909, to reach the site of the waste-gate structure at the right-hand end of the dam. In order to be able to handle the flood flow of the past season through the restricted channel that would be left at the time that flow occurred, it was necessary to have the waste gates ready before the river began to rise. Work accordingly was started in February, 1909, on the structure containing them, and rushed as fast as possible. The 5 to 8 ft. of water at the site was flowing at a high velocity, due to the rapids at this point, the throttling of the channel by the submerged crib dam on the opposite side and the obstruction presented to the flow in this channel by the submerged crib dam on the opposite side and the obstruction presented to the flow in this channel by the cribs carrying the construction track. A rock and earth-fill shear dam similar to those built on the other side at the start, accordingly was advanced from the river bank above the adjacent end of the main dam. This shear dam, which was riprapped on the channel side to prevent the current from scouring it, was continued for about 600 ft. to a point well below the downstream limits of the masonry in the waste-gate section.

As the current then was cut off from the site of the waste-gate section, a low cofferdam back of the shear dam permitted the necessary area to be unwatered by the middle of March. Following that, work on the waste-gate section was rushed, in order to have the gates ready before the rise in the river. The 2700 cu. yd. of concrete required were brought across from the mixing plant on the opposite side in the 4-yd.

cars. The latter dumped their loads on shoveling boards, on which the concrete was hauled to place in wheelbarrows or handled in skips by a guyed derrick. Simultaneously with the work on the concrete, a 40-ft. section of the rock-filled timber-crib spillway was built to join into the outer end of the waste-gate structure. All of the work at that end of the dam was finished to above flood gate before the rise in the river, so when the high water carried out the cofferdam around it the five 8 x 10-ft. gates were available to discharge a part of the flow.

The construction of the rock-filled timber-crib spillway and its apron was begun in December, 1908, at the left-hand end of the structure, as soon as the permanent submerged-crib dam had unwatered that side of the river above the falls. From that time it was carried on continuously, while the other operations already described were being prosecuted. As a result, by April 1, 1909, the crib work on the spillway had reached a cofferdam built across its site, as a continuation of the permanent submerged crib. A channel width of 240 ft. was left between this cofferdam and the one which unwatered the site of the waste-gate section at the right-hand end of the dam. A schedule of operations was adopted to permit this channel to be left open during the time of high water of the past summer, without interfering with work on the dam. The high-water stage was maintained longer than usual, however, the volume of flow remaining close to 7000 cu. ft. per second during August, and was in the neighborhood of 4,700 cu. ft. per second as late as November 1. Consequently, the adopted schedule had to be altered somewhat, but this was done without serious handicap.

When the stage of the river began to fall last September, all but one of the spaces between the 16 x 16-ft. cribs carrying a track across the channel had been closed. This final opening was directly above and just off-shore from the waste-gate structure, the crib at one side of it being against the latter. The flow of the river thus was directed through a channel about 20 ft. wide, beyond the end of the section of the spillway already completed in connection with the waste-gate structure, and through the five openings in that structure. Then the spillway was continued out into the unwatered channel that had been left previously to carry the flood flow, so that the final closing section of it was only 57 ft. in width.

The openings between the cribs, placed to carry the track across the channel, were closed separately by sinking cribs directly in them. These closure cribs had 12 x 12-in. horizontal timbers long enough to take bearing at both ends on the upstream side of the 16 x 16 ft. cribs placed originally. These horizontals were spaced 12-in. apart vertically, and attached normal to each of them were 12 x 12-in. timbers. With a second horizontal timber at the downstream end of the opening, a grid that just fitted the latter was formed. These grids were built up in place, as the crib formed by them sank of its own weight. The upstream side of the closure cribs was sealed with 4-in. splined sheeting to prevent the passage of water through it, so that a wing of the permanent submerged dam was formed in this manner. The closures also were made without difficulty, even though the velocity through the openings was excessive.

Before the final closure was made a timber-crib cofferdam, extending from the outer end of the tight dam formed by closing the openings between the 16 x 16-ft. cribs, was built parallel with the current to a point below the site of the main permanent dam. A channel 20 ft. in width thus was left between this coffer-

dam and the short section of spillway built into the outer end of the waste-gate structure. The flow of the river, as mentioned, was discharged through this channel and through the five 8 x 10-ft. gate openings until the final closure was made. The hydraulic grade of the water flowing through the channel was so steep that a low bag dam extending downstream to the crest of the falls prevented any backwater from reaching the uncompleted section of the main dam protected by the final cofferdam.

The last opening between the 16 x 16 ft. cribs was finally shut off by a repetition of the method already described, before the final closure of the main dam was undertaken. Since the waste gates were not expected to have sufficient capacity to discharge the flow of the river, three 7 x 16-ft. openings were left temporarily through the permanent spillway to carry the surplus without interfering with operations in the closing section of the latter. These openings were provided by simply omitting in front of them the sheeting on the upstream face of the spillway and the rock ballast in one of the transverse rows of pockets of the dam. The sheeting on the downstream face of the spillway also was omitted temporarily for some distance on both sides of the three openings, in order to give the water ample opportunity to escape through the rock fill in the pockets of the cribs. The adopted scheme contemplated that after a final closure was made timber gates would be lowered on the face of the spillway to close the openings in the upstream face. With the flow thus shut off, the rock fill and the omitted portion of the deck on the downstream face could be placed in the dry before the crest of the dam was overtopped.

The great quantity of timber required in the dam, amounting to over 5,000,000 ft., was obtained from several mills in Oregon, as no one mill was in a position to supply it as fast as it was used. The timbers are cut to sizes at the mills and shipped on flat cars directly to a yard on the side of the hill at the left-hand end of the dam. During the first work on the dam they were hauled out from this yard on the service tracks, which were extended close to the point where the timbers were required. Later a track laid on the permanent submerged crib permitted the timbers to be hauled out and dropped into a pool above the completed part of the spillway. They could then be floated to the point required, where they were pulled out of the water and drawn up the face of the spillway by an air-driven hoisting engine moved along on the apron of the dam as the work progressed. Although the timbers were cut to sizes, considerable framing was necessary to obtain accurate joints at the intersections and to maintain the alignment of the face of the dam. Each timber was framed immediately before being placed, the work being done largely on floats in the pool in front of the toe of the spillway.

The large number of holes that had to be bored through the timbers for the drift bolts and for other purposes were made with pneumatic boring machines. The great quantity of drift bolts, ship nails and spikes required were driven by means of riveting hammers of the largest size. No precedent of similar adaptation of these tools was available, and no assurance could be obtained that they would do the work required. Since upwards of 100,000 of the $\frac{7}{8}$ -in. drift bolts, 24 and 28 in. long, and a corresponding number of ship nails and spikes had to be driven, however, it was essentially imperative to eliminate hand sledges. Besides, most of the driving had to be done on the

steep slopes of the dam, where it was difficult for men with sledges to secure a foothold. The riveting hammers accordingly were tried and were most successful from the start. They not only reduced the cost of driving materially, but also cut down the number of men required on the dam, so those who remained could work without interference, which was a most important factor under the conditions presented.

The rock used in filling the dam was obtained from a quarry opened in the left-hand bank of the river directly above that end of the railroad bridge. The quarry output was delivered to place in 4-yd. cars hauled by the 10-ton locomotives operating over a 36-in.-gauge track. During the first part of the work this service track was laid to the left-hand end of the dam and then continued out along the latter. When the permanent submerged-crib dam was finished, the track on it then was extended on a trestle to the crest of the spillway and continued along the top of the latter so the stone could be dumped directly down the face of the timber crib. Although the rock was delivered very satisfactorily in this manner, care was taken to see that it was well grouted into the pockets, so that no large spaces were left in the latter.

The concrete used in filling the apron of the spillway was delivered from the mixing plant in the 4-yd. cars by the 10-ton locomotives operating over a track laid on the cribs, the full length of the apron. This track was first placed about 8 ft. from the downstream edge of the latter, and from this position the apron was filled to a width of 8 ft. Then the track was shifted toward the other edge and the balance of the pockets filled.

The excavation for the penstocks and the forebay of the power house, involving together nearly 100,000 cu. yd., was made almost entirely through shale. A 70-ton Bucyrus steam shovel was employed in taking out all this material, most of which was loaded into the 4-yd. cars. The balance was placed along the side of the trench, to be used later in back-filling the penstocks. The steam shovel also dug an overflow channel, extending from the forebay downstream to a gulch, through which surplus water will be delivered back to the river.

The power-house site was covered with from 1 to 5 ft. of water at the normal stage of the river, and was in the midst of a rapids in the latter, with a long, narrow island separating it from the main channel of the stream. In order to permanently unwater the channel on the power-house side of this island, a shear dam was built from the corresponding bank of the river out to the crest of Crooked Falls, at the head of the channel. A rock and earth-fill shear dam was first built on the upstream side of the site of this permanent dam in the same manner that was followed in similar work above Rainbow Falls. The shear dam is a continuous rock-filled timber-crib structure, 16 ft. wide, 18 ft. high and 320 ft. long, that is sealed on the upstream side with a tight wall of 4-in. sheeting. A fillet of concrete also was placed at the base of this wall to prevent any flow under the dam. The latter was completed only a few days before the rise in the river last May, when it was subjected to a head of 6 ft. without any evident signs of weakness.

The excavation for the tail-race and power house required the removal of about 45,000 cu. yd. of sandstone bed rock. The blast holes necessary in loosening this rock are made with tripod drills, operated by air supplied from the pipe lines extending from the temporary power plant adjacent to Rainbow Falls. The stone loosened by blasting is loaded by hand into 2-yd. skips, which are hoisted out of the pit and dumped into cars operating on a track along the chan-

nel side by guyed derricks set up at convenient intervals. These derricks are operated by electric hoists, and are moved as the work progresses. The spoil from the excavation has been used in making the fill on the channel side of the tail-race, in order to protect the latter from the high-water stages of the river. Since the hydraulic grade of the latter is quite steep, considerable advantage in head is thus secured.

In all of the work that has been done, comparatively little water has been encountered in the areas enclosed by the cofferdams. In fact, the flow which it has been necessary to remove is so small that a few 3-in. centrifugal pumps belted to 15-hp. motors have been able to handle it, and these pumps are operated only part of the time. The unit made up of a centrifugal pump and its motor is mounted on a skid, so it can be shifted from place to place very rapidly.

The officials of the Great Falls Water Power & Townsite Company are Messrs. John D. Ryan, president; Mr. John G. Morony, vice-president; Mr. W. M. Thornton, secretary-treasurer, and Mr. Frank Scotten, manager of the construction department. Mr. Charles T. Main, of Boston, Mass., is consulting engineer for the company, and Mr. Henry A. Herrick is engineer in charge of the entire design and construction.

CEMENT AND CONCRETE FOR PROTECTING PILES IN SEA WATER.

A paper presented by Ralph Barker at the convention of the National Association of Cement Users.

The principal enemies of timber structures in sea water are the limnoria and the teredo. The limnoria works at the surface of the water and makes his attack on the outside of the timber, and does not enter and live in it. Consequently, when a pile has been exposed to this insect a sufficient length of time, it has the appearance between high and low water of an hour glass, the narrowest part being at mean tide level, where it has been exposed the greater length of time. The limnoria does not destroy timber as fast as the teredo, and its sphere of action is not so great. Also, when a pile is eaten enough by the limnoria to impair its strength the fact is obvious, which is not true of the teredo.

The teredo, the most destructive foe to timber work in sea water, works between the mud line and mean low water. He enters the timber in the form of a minute worm, making a hole in the shell of the timber no larger than a pin. After entering the wood he grows rapidly, boring his way rapidly through the grain of the wood, the size of the hole rapidly increasing to accommodate his increasing size, until it is frequently $\frac{1}{2}$ in. in diameter. The small hole through which the borer entered remains at its original small size and the timber, if not otherwise attacked, appears as sound as ever.

This insidious enemy infests the waters of the Pacific Coast in enormous numbers, and is the most destructive by far with which we have to contend. Untreated fir piles in the Bay of San Francisco have been so riddled by the teredo in eight months that their bearing capacity is practically nil, and a very slight transverse strain would break them.

It is plain from the foregoing that the use of untreated timber for the support of structures in sea water infested with these marine borers is absolutely out of the question, except for extremely temporary work.

The methods of treating timber may be divided into two classes: (1) The impregnation of the wood

with a chemical distasteful to the insects which attack it. (2) The placing of some substance around the timber which is impervious to the attack of such insects. The first method is very largely in vogue on the Pacific Coast, but is open to many objections, its principal recommendation being its cheapness. The latter method is coming rapidly into use, and as concrete is the cheapest, most available and most readily applied material, it will probably supersede all others.

The one great requisite essential for a hydraulic cement, regardless of the special purpose for which it is to be used, is that when properly handled it shall form a strong and permanent bond; that when hardened it shall become an enduring and resistant matrix for the inert particles of sand and stone, together with which it forms an artificial conglomerate stone.

As to the type of hydraulic cement best fitted to secure this general essential quality of enduring strength when used in sea water, the subject has been, and still is, one of considerable question. The two destructive influences commonly believed to be most necessary to provide against are: (1) The peculiar chemical disintegrating action of the magnesian sulphate content of ocean water upon the aluminum compounds in the cement. (2) The physical wear of the surface of concrete thus chemically affected and softened by the abrasive action of the water, and the greater or less content of sand which it may carry with it.

Naturally, the first endeavor has been to produce a cement so constituted that the chemical action of the sea water should be reduced to a minimum.

Basing their work upon the theory that the aluminum content of a cement could, for fluxing purposes in manufacture, be replaced by iron, which is not affected deleteriously by magnesian sulphate, German makers have placed upon the market an "iron ore cement" or "erz-cement," as it is called. Accelerated tests of this material have been made by the makers, by immersing mortar blocks in sea water of intensified strength. These tests as reported seem to prove that as compared with Portland cement of the usual character, under the same conditions, the iron ore cement blocks withstood the chemical action of the sea water very much more successfully.

Tests of imported iron ore cement are now under way in San Francisco, comparing it under exactly similar conditions with a Portland cement made in California. These tests have been running for only 6 months, up to the time of writing, and on that account may not be exactly conclusive. The results of these tests as far as carried are as follows:

Tensile Strength in Pounds Per Square Inch of Iron Ore and Portland Cement Briquettes Stored in Fresh Water and Sea Water Five Times Normal Strength.

SPECIMEN	Age Days	STORED IN FRESH WATER		STORED IN SEA WATER	
		Iron Ore	Portland	Iron Ore	Portland
Neat.....	30	653	704	853	863
	90	825	725	981	1,019
	180	808	801	1,026	1,160
1:3 Mortar ...	30	359	396	343	441
	90	499	465	493	508
	180	526	491	486	479

Another series of systematic experiments made with the purpose of determining the question of a resistant cement for sea water were begun 14 or 15 years ago by the German Government at the instigation of the Puzzolan-Portland cement manufacturers. Puzzolan-Portland is a mixture of either natural puz-

zolan, a volcanic ash, and Portland cement, or of artificial puzzolan, blast furnace slag of certain chemical composition, and Portland cement. Depending upon the chemical composition of the puzzolan, the mixture contains from 30 to 60 per cent of puzzolan and from 50 to 70 per cent of Portland. The mixture can be made after pulverization, if necessary, by the engineer or contractor on the work. Preferably, however, the ball-mill product of both ingredients are pulverized together in the tube or other finishing mill at the cement factory.

The result of the German Government's experiments at the royal testing station at Berlin, carried through a fairly long series of years—the five years' tests have recently been completed—seem to prove rather conclusively that under exactly similar conditions of mixture and subsequent immersion in sea water, the Puzzolan-Portland concrete showed higher strength than the pure Portland concrete in both tensile and compression tests, and that the Puzzolan-Portland concrete blocks with which the tests were made held their original form in much better condition than did the blocks of concrete made with pure Portland, the latter having very visibly suffered from chemical action and abrasion in the sea water.

As to the comparative economical value of Puzzolan-Portland and pure Portland in the rich concretes made for the German Government tests in sea water, the results seemed to prove that a barrel of the Puzzolan-Portland was equal in producing resistance to the action of sea water to two barrels of the pure Portland.

An examination of the two types of concrete blocks used in these experiments also seemed to prove true the theory of Dr. Michaelis that the hardening of the Portland cement in the Puzzolan-Portland mixture was accompanied by a chemical decomposition in which a portion of the combined lime in the pulverized clinker was transformed into lime hydrate, and this latter, in some measure at least, made another combination with the pulverized puzzolan, producing a puzzolan hydraulic cement invulnerable to sea water.

Final corroboration of these sea water experiments and their results in this country will be awaited with great interest. At the present time, however, Puzzolan-Portland is not manufactured in the United States, although deposits of proper constituted volcanic ash, suitable for the purpose, undoubtedly exist in numerous parts of the country. The American engineer has been principally confined in sea water concrete construction to the use of Portland cement.

Tensile Strength in Pounds Per Square Inch of Portland Cement Briquettes Stored in Ocean and in Fresh Water.

SPECIMEN	Age Days	BRAND A		BRAND B	
		In Ocean Water	In Fresh Water	In Ocean Water	In Fresh Water
Neat.....	30	1,132	844	1,119	827
	90	1,097	762	1,203	733
	180	1,065	737	1,113	823
1:3 Mortar .	30	522	468	366	354
	90	540	537	385	415
	180	521	549	449	474

Chemical Analyses of Above and Portland Cements.

	Brand A	Brand B
Silica (SiO ₂)	21.62	21.52
Iron (Fe ₂ O ₃).....	2.15	3.57
Alumina (Al ₂ O ₃)....	6.75	7.05
Lime (CaO)	63.80	62.00
Magnesia (MgO)	1.94	1.29
Sulphuric Anhydride (SO ₃).....	1.17	1.37
Ignition Loss	2.20	2.05

Although disastrous disintegration has occurred in some instances, it is nevertheless true that the great mass of well-constructed Portland cement concrete in sea water has served its purpose satisfactorily. Portland cement concrete has the power of armoring itself against the action of the magnesian sulphates of the sea water by the formation on its exposed surfaces of a skin or film of lime carbonate. In comparatively still waters this appears to constitute a very effective protection. In case of violent or continued abrasion of water and sand it is naturally less effective, and in exceptional cases has no opportunity to form. In these cases the calcium hydrate set free by the decomposition incident to the hardening of the Portland cement is washed away, leaving voids for the further inroads of the deleterious chemicals contained in the sea waters.

In selecting a Portland cement for marine construction, for at present the American engineer is in large measure confined to choice of cements of the common type for work of this class, the ordinary precautions taken to secure a trustworthy material, i. e., careful and accurate sampling and testing, are absolutely essential. The standard specifications of the American Society for Testing Materials indicate the requirements admirably in the main. That the cement must be sound goes without saying. Since only the very finest portion, the "float," of the Portland has cementitious value, fine pulverization is essential, and a matter of much economical moment. Too slow a setting is to be avoided, and a rapid permanent hardening is of value. These, however, it is unwise to secure by the use of cements high in aluminum, since it is the aluminum content that is most vulnerable to the chemical attack of sea water.

That it is possible to secure a rapidly hardening cement that is not unduly high in aluminum content is evidenced by the foregoing table of tests of two brands of Portland cement made in the State of California, with chemical analysis of the cement thus tested.

Methods of Application at San Francisco.—Since the teredo works from the mud line to low water, and the limnoria from low water to high water, it is necessary in order to insure immunity to protect timber from the mud line to high water mark. As the mud line is a somewhat varying factor, it is very desirable to extend the covering to a sufficient depth to preclude the possibility of the unprotected portion of the timber becoming exposed.

Three methods have been used extensively in San Francisco harbor for applying concrete to piles. Two of these methods are applicable only to new structures before the superstructure is in place, while the third may be applied to the piles at any time.

The first method covers the use of a metal or wooden cylinder around the pile and filling same with concrete. This method was first employed in 1894. Steel cylinders $3\frac{1}{2}$ ft. in diameter were used around a cluster of three piles. First the piles were driven in the proper locations, then the mud was removed from inside the cylinder to a depth specified. This depth was governed by conditions, and was usually about 30 ft. below low water. Then concrete sewn up in loose mesh burlap sacks was placed in the cylinder in sufficient quantity to fill it nearly to low water line. This was allowed to set and the water was then pumped out and the balance of the cylinder filled with loose concrete. This method was later cheapened by the substitution of wooden stave cylinders for the steel.

The most recent practice in this method is to use, instead of a $3\frac{1}{2}$ ft. cylinder, one only 2 ft. in diame-

ter, having a cast-iron shoe in its bottom which fits as close as possible around a single pile. Rope grummetts are placed around the pile, and as the cylinder is driven the grummet is forced tightly between the casting and the pile, thus making a tight joint, which excludes the mud and water to a very great extent. What mud and water may have gotten inside the cylinder is then removed by a jet pump and the cylinder is filled with concrete, same being reinforced with vertical rods held in place by horizontal bands. The latter practice gives the best results, as the placing of concrete under water, even in sacks, is almost certain to cause a separation of the ingredients. The wooden cylinder is eaten away by the marine insects in a short time, and if the concrete is not perfectly sound the teredo enters and destroys the piles.

The second method consists of using a concrete cylinder of about 24 in. external diameter and $2\frac{3}{4}$ in. thick, heavily reinforced. The length of the cylinder is governed by conditions the same as the wooden cylinder above described, the longest used being 34 ft. The cylinder is driven around the pile, pumped out, and filled with concrete in practically the same manner as when the small wooden cylinders are used. This method gives very good results, as the outer shell is made on the surface, where it can be examined and rejected if defects appear.

The third method differs essentially from the foregoing, and can be applied to an old structure without removing the top work. It consists of the use of a sheet metal form having a diameter of about 8 in. greater than the pile to be treated, same being placed around the pile in short lengths. The bottom of the first form applied to the pile is equipped with a diaphragm, which fits closely around the pile and accommodates itself to its decreasing size. The form is placed around the pile and has attached to it two wire ropes from a windlass on the floor of the structure. Then a cylinder of reinforcing material is placed inside the form and it is filled with concrete. This section is then lowered into the water sufficiently to allow the next section to be constructed around the pile and fastened to the one already filled. The process is continued until the first section comes to rest on the bottom of the bay. In ordinary mud the weight of the column of concrete will force it down into the bottom a sufficient distance to insure protection.

All three of these methods give very good results. The last mentioned is the cheapest, but when it is used the pile it protects must extend up to and support the superstructure. In the other two methods the pile may be cut off at low water line, and the balance of the support made a reinforced pillar, getting its lateral strength from the reinforcing bars, which may be made continuous for the full length of the concrete casing.

SAND-LIME BRICK OR BLOCK NEWS.

The International Sand-Lime Brick & Machinery Co., of 90 West Street, New York, has secured a contract for the erection of one of their complete Silicate Brick and Stone Factories, near Albany, Ga. This factory will be a Standard Single-Unit Plant, with a capacity of 20,000 bricks per day of 10 hours, or 40,000 bricks and 200 cub. ft. of Silicate Stone per day of 24 hours. It will be equipped throughout with the most modern and up-to-date Machinery and Special Appliances, owned and controlled by International Sand-Lime Brick & Machinery Co., including the patented "Division-Method." The buildings are to be entirely of steel and concrete construction, making the

plant absolutely fireproof. Work has already been started on the erection of the buildings, and it is expected that the factory will be in operation within 90 days.

A Company is being organized in Eastern Pennsylvania, for the manufacture of Silicate Brick and Stone products under the "Division-Method."

The Canadian Brick & Stone Co., of Canadian, Tex., has been organized to manufacture Silicate Brick and Stone and it is expected that work will soon be begun on the erection of the factory, which will have a capacity of 20,000 brick per day.

The Florida Sand Stone Brick Co., of Jacksonville, Fla., will remodel their plant in the near future and double its capacity to 40,000 brick per day.

REINFORCED CONCRETE BARGES FOR PANAMA CANAL.

Work will be commenced shortly on the construction of three concrete barges, to be used in supporting the dredging pumps for the hydraulic excavating and pumping plant of the Pacific division of the Panama Canal.

Each of the barges will be 64 ft. long, 24 ft. wide, and 5 ft. 8 in. deep. The interior beams and columns will be spaced 10 ft. apart longitudinally, and 8 ft. transversely. Wooden forms will be used in their construction and the barges will be launched sideways. Two interior longitudinal walls will extend throughout, with a bulkhead at each end, forming an interior compartment 40 ft. long and 8 ft. wide. The interior form work will be built in collapsible sections, so that the latter can be removed readily as the work advances. The frames for the hull will be constructed first, and the preliminary work will consist of the erection of supports on which wooden forms will be placed.

The wall construction will consist of one layer of $\frac{1}{2}$ -in. mesh No. 12 wire cloth; $\frac{1}{2}$ -in. transverse rods spaced 8 in. on centers, and $\frac{1}{2}$ -in. longitudinal rods spaced 12 in. on centers, all securely fastened to the reinforced concrete framework described above. The sidewalls and bottom of the barge will then be formed by laying on several coats of plaster made of Portland cement mortar, and troweled down to a hard surface. The plaster will be laid on first from the outside, and an additional coat laid on from the inside, so as to thoroughly cover the $\frac{1}{2}$ -in. mesh and steel rods.

The deck of the barge will consist of concrete slabs $3\frac{1}{2}$ in. thick, having spans 10 ft. in length and 8 ft. in width, reinforced with $\frac{1}{2}$ -in. rods, both longitudinally and transversely. Wells are provided for pumping.

The dredging pump, motor and equipment, weighing approximately 60,000 lbs., will be located near the middle of the barge. The maximum draft of the barges, when loaded, will be about 3 ft. They can be moved readily from one place to another in the channel, and each will be equipped with four mooring bits situated a few feet back from each corner, secured to the barge by long bolts imbedded in the concrete of the side columns and diagonals.

The barges will be erected on cribbing built for the purpose, and launched from ways, on the west bank of the basin, a short distance south of the Miraflores lock site.

While the construction of barges from concrete is not a new idea, its adaptation is not known to have hitherto been attempted in this country. Concrete barges have been successfully used in Italy during the

past few years and recently the use of this material in the construction of floating craft in that country was extended to the building of transfer boats, a type of vessel similar to the New York car ferries. The plans of the Pacific division barges contain numerous modifications from the Italian type, some to meet local conditions, and some because of the continual improvement in concrete construction methods.

A PLANT FOR UNLOADING CEMENT.

In order to facilitate the unloading of cement at the piers at Cristobal a contract has recently been let by the Panama Railroad Co. to the Alvey-Ferguson Co., of Louisville, Ky., for a system of cement conveyors.

There will be six conveyor units, two for cement in bags and four for cement in barrels, and each unit the bags to any point along the railroad track. It is to have a maximum capacity of 1,000 bags or barrels per hour. The price of the complete system of conveyors is \$29,760.

Over 4,000,000 barrels, or over 800,000 tons of cement, are yet to be brought to the Isthmus for use in the construction of the locks of the canal, and for other purposes, most of which will be carried in steamships. Each vessel makes one round trip a month between New York and Cristobal, and each has a maximum capacity of approximately 10,000 tons of cargo, usually about equally divided between cement and general freight.

The unit for bags is composed of three parts: (1) A vertical elevator for raising the bags of cement from the hold to the deck of the ship, consisting of a vertical shaft on which revolves an endless chain of brackets; (2) a portable apron conveyor at right angles to the ship, built in sections 20 feet long, which conveys the bags from the deck of the ship to the pier, and which has two towers for adjusting the aprons as the vessel lightens and rises in being unloaded, there being a difference of 12 feet between load and empty draughts; (3) a stationary apron conveyor, built lengthwise on the pier, which delivers

The conveyor unit for barrels is composed of two parts: (1) A vertical elevator, the same as in the unit for bags; (2) a barrel lowerer, with an adjusting tower, which conveys the barrel of cement from the deck of the ship into the hold of the barge alongside. Hand labor will be required at three points only with



Loading Cement on Barges at the Plant of the Alsens Portland Cement Company. Showing Conveyor Handling Finished Product. Belt Conveyors and Equipment Made by Robins Conveying Belt Company, New York City.

the conveyor system, viz., in placing the bags or barrels of cement in position on stationary brackets, located on each of the three decks of the hold, so that the brackets on the vertical elevator can raise them; on the pier, in transferring the bags from the stationary conveyor to the freight cars, and in the hold of the barge, in removing the barrels from the lowerer and stowing them away.

ROADS PLAN TO USE CEMENT POLE.

This is Especially the Case in the West, Where Fires Frequently Lay Wires.

Cement telegraph poles and cement fence posts will soon be a familiar sight along the rights of way of the railroads if predictions made by producers of this material are fulfilled.

Already, it is said, some of the great railway systems are planning to use cement poles on which to string their telegraph wires, and the big telegraph companies likewise have discussed the advisability of employing cement for their wires. Good telegraph poles are becoming scarce, but it is not solely because of this that the railroads are beginning to use cement. It is claimed that a cement pole will be better in many ways. As a minor consideration, they can be made more sightly, but the chief reasons are the saving of money through the durability of the cement pole. Railroad and telegraph companies now suffer much loss, it is claimed, from wind storms. The wooden pole rots and is easily broken, whereas a cement pole would not have to be replaced in many years.

Especially in the west, where the railroads often have prairie fires to encounter, it is said that in a few years' the fence post of cement probably will be in general use. The right of way of the big railroad now is fenced off with barbed wire strung on wooden posts, often destroyed by fire. When the cement post is in use fire will have no effect, and the saving to the railroad company will be immense. Ties for the roadbed also are being made of cement. Concrete passenger stations are being built by the railroads, and cement is to be used in the construction of some of the great freight depots.

FINE GRINDING OF CEMENT.

In commenting on a paper on the above subject, read before the American Society for Testing Materials, by Mr. Richard K. Meade, the following statements are made by Mr. Kenneth Hartley in Engineering News:

There is nothing mysterious about the increase of strength due to fine grinding and I think most of the uncertainty and difference of opinion on this matter is due solely to our inaccurate use of terms. A pile of unground clinker is not cement and it does not become cement until it is ground to such a degree of fineness that it is capable of uniting with water to form a hydrate. If this is a correct definition then the material which does not pass through a 200-mesh sieve is not cement at all, but merely small particles of clinker, for it has no cementing properties remaining unaffected by water either cold or hot for any length of time.

It is a fact less generally recognized that a large percentage of the material that passes through the 200-mesh sieve is still not fine enough to be acted on by water and therefore not really cement. If engineers would realize that a sack of ordinary cement

contains only about half its weight of actual cement, the remainder being the equivalent of fine sand, they would be more ready to accept the idea that if the manufacturer can reduce the percentage of inert material in a sack of cement the engineer may replace this with an equal amount of sand without reducing the strength of the concrete.

Mr. Meade's statement that an increase of 1 per cent. in fineness, as measured by the 200-mesh sieve, would result in an increase of 2 per cent. or more in strength is only true in some cases, for the strength is not proportional to the percentage that passes the 200-mesh sieve, but to the percentage of powder fine enough to be acted upon by water. Now that the improvements in grinding machinery are making finer grades of cement commercially possible, I think that cement experts should give more study to this matter along the following lines:

(1) To determine the maximum size of particles that are chemically active.

(2) To devise a practicable method of testing the fineness of cement to determine the percentage of particles that are below this size.

(3) To demonstrate the relation between the percentage of fine powder in the cement and the crushing strength of concrete made from it.

(4) To discover the best method of proportioning concrete, based on the fineness of the cement, so as to secure the greatest benefit from the finer grinding, either in strength or economy.

ANOTHER USE FOR CEMENT.

Every railroad man in the country will be interested in the tests of a cement railroad tie which will be shortly instituted by the Hocking Valley railroad. If it succeeds it will solve a problem which has been a bug-a-boo of all railroad builders in recent years and will aid in the work of conserving and replanting our forests.

For the past decade railroad men have been casting about for a substitute for the wood tie. The thousands of miles of new track, main line and sidings which are being laid every year creates a constantly increasing demand for railroad ties. In addition to this the life of the average railroad tie is but a few years, necessitating new ties to replace the ones which have become rotten and weak from the constant exposure to the weather. The demand for railroad ties has resulted in the denudation of thousands of acres of forest land and the destruction of great stretches of standing timber. It has eaten away one of the most valuable of our natural heritages until but a shadow of it remains and if the present demand keeps up, it will be impossible to supply it. The railroads everywhere are planting trees along their rights of way in the vain hope that they will be able to grow enough timber to supply the demand for railroad ties but it seems that it will be impossible to meet but a small percentage of the need in this manner.

Inventors have endeavored to find some substitute for wood as a support for the iron rails of the railroads but up to date their efforts have been in vain. All manner of metal combinations have been tried; concrete and clay ties have been constructed but there has always been some defect in the substitute tie which rendered it worthless. Either the material was not durable enough to stand the strain of the heavy jolting cars passing above or it was not elastic enough to meet the requirements of the rails.

Recently however a new tie has been brought to

the notice of the railroads constructed of cement with and iron bar passing through the center and resting upon a patent cushion which relieves the jar of the trains passing over it. The Hocking Valley has authorized a thorough test of the new tie in the hope that it will fill the long felt need. If successful the inventor has a fortune in sight which will surpass the dreams of Midas. His invention will be snapped up by every railroad in the world and he will be able to command almost any price for his patent rights. It will prove one of the most far reaching inventions in the railroad world today and at the same time will result in the saving to mankind of the millions of trees which are consumed yearly to supply the demand for the ties.

CANADIAN CEMENT CO'S NEW SALES MANAGER.

W. H. Ford, of Montreal, has been appointed general sales manager of the Canadian Portland Cement Co., Ltd., which comprises practically all of the cement mills in the Dominion, as a result of the great merger.

Mr. Ford is a southern gentleman, only a little past thirty, and has had a wonderfully successful career in the cement industry. He hails from Charleston, S. C., and began as salesman for the Carolina Portland Cement Co.

In 1906 he was chosen by the late Robert Horner, of the Kosmos Portland Cement Co., of Louisville, Ky., to become sales manager and introduce the then new Kosmos brand. For two years in this connection his efforts were crowned with phenomenal success, and in 1908 he went to Montreal as vice-president of the W. G. Hartranft company, to introduce the new Vulcan brand in Canada.

UNRELIABILITY OF THE COLD PLUNGE TEST FOR CEMENT.

(Paper by Arthur C. Davis, read before the Institution of Civil Engineers.)

The recently introduced method of testing the soundness of Portland cement, termed the "cold plunge" test, consists of the immediate immersion of a small pat of cement in cold water, as soon as gaged and, after some hours, when the cement has set, unsoundness is looked for in the cracking on the surface of the pat or, more particularly, in its distortion, which sometimes separates the pat from the glass upon which it was placed under water.

The above test for soundness is included in some cement specifications, where the terms of the British Standard Specification are not adopted, and a clause such as the following is used:

"The cement shall be thoroughly sound and well cooled. Pats on glass made therefrom must show no sign of contraction, expansion, or disintegration whether (1) after being kept in a humid chamber or in water for 24 hours, they are placed in cold water, which is then brought rapidly to boiling point, and kept thereat for 12 hours; or (2) they are plunged into cold water shortly after being gaged and kept there for any length of time; or (3) they are kept entirely in the air. The boiled pats must not show any tendency to hold water, but must dry immediately on being taken out of the hot water. The 'plunge' pats in addition to not being cracked, warped, etc., must have a firm and permanent adherence to the glass."

The cold plunge test is one which many otherwise perfectly sound and expansionless cements often fail

to pass, and many experiments have been undertaken with a view to ascertaining the scientific reason for so many cements showing a surface cracking and distortion under this test—which has only recently come into vogue—and to appraise its value. From such investigations, however, it cannot as yet be definitely or clearly stated whether or not failure to pass the test indicates a defect in the cement, but the results of many experiments show that at all events surface cracking in a pat of cement immediately immersed in water is as often caused by its manipulation in testing as by any defect in or action of the cement when immediately immersed in water, on gaging. Indeed, the defects disclosed by experiments up to the present appear to relate chiefly to cements of slow-setting qualities and to conditions altogether apart from soundness.

In describing the results obtained in an effort to ascertain the cause of cements cracking in the cold plunge test, it is necessary, in passing, to refer to the superficial or common occurrences which may explain away some of the difficulties encountered.

It is, for instance, generally assumed that cement containing gypsum will always fail to pass the cold plunge test, and the presence of gypsum in a cement is thus held to be the cause of superficial cracking; but this view is quite erroneous. It is true that many cements containing gypsum are liable to failure in this test, owing perhaps to their slow-setting nature, but many cements containing as much as 3 per cent of gypsum will appear sound in the cold plunge test, whilst many which do not contain gypsum, or any other addition to the clinker, whether rotary-kiln burned or otherwise, will show "skin" cracking and will lift off the glass. Failure, when it occurs, may be due to the light, fine particles of gypsum and cement being brought to the surface by the trowelling and shaking of the pat whilst in preparation. But, from experiments which have been undertaken, it seems reasonable to conclude that the treatment of the pat has more to do with the surface cracking under the cold plunge test than has the presence of gypsum, although this may not apply to the lifting of the pat at the cement edges. It is difficult indeed to say how gypsum could affect under this test, except that, by retarding the setting of the cement, it might allow the mass to come to a state of equilibrium so far as content of water is concerned; but if the setting of the cement is allowed to commence before immersion the cracking might thus be diminished.

The difference in the behavior of quick-setting and slow-setting cements under the test, however, quite apart from the gypsum content, is that the former under certain circumstances obtain, immediately after gaging and when setting has commenced, such a mechanical strength that they may be put under water without cracking; but with the slow-setting cements, which are of a much higher value relatively to this strength, this is absolutely impossible, and, therefore, it would follow that the action of the cements under water depends more generally upon the course of setting than upon composition. Accordingly, an impartial examination would only be possible after setting has started, that is to say, when the various cements under test have reached a certain degree of uniformity of plasticity.

Or, again, it might be supposed that the surface cracking of cements when immediately immersed in cold water, was due to the swelling of the pat from absorption of additional water, whilst setting was proceeding. If this is the case, the percentage of water used in preparing the pat would, of course, greatly affect the result.

Further, freshly made cement may be prevented from setting by immediate immersion in cold water, chiefly because the components of cement on the formation of which the setting of the cement is based, dissolve and are kept dissolved in the large surplus of water. If the inner parts of cement pats are less unfavorably influenced than the surface, this may be simply because through the outside layer they are protected from immediate contact with this large surplus of water until the upper layer is destroyed and dissolved during setting. The inner parts of the pat thus have time to harden sufficiently to enable them to resist dissolution by excess water.

It has also been observed on experiment that the temperature of the water into which the cement pat had been plunged is sometimes the cause of surface cracking under this test. For instance, the soundness of a number of pats immersed in water with a temperature of 66° F. will not be affected by the cold plunge test, while the same cement made into pats will lift, and crack on the surface, if put into water with the temperature of 45° to 50° F.; and again, it has been noticed that in the case of two pats of the same cement prepared in exactly the same way, if one is put under fresh water and the other under the older (and alkaline) water contained in the briquette tray in general use, the latter pat will remain sound, while the former appears unsound, owing to the alkaline water hastening the set of the cement.

Further, the soundness or unsoundness of a pat under this test is controlled to a large extent by the time elapsing between the finishing of the preparation of the pat and its plunging under water. The same cement made into two pats will act in the following manner under this test:

One pat put immediately under water as gaged will show a surface cracking, and the other pat, if allowed, before immersion, to get a dull surface, after some 15 to 20 minutes in the atmosphere (a condition showing that the initial set is likely to take place within the next 15 minutes), will, when immersed in water, remain perfectly sound.

The pats in the cold plunge test are also affected by vibration of the water in the tank in which they are immersed. If the tank remains perfectly still, and the water is not interfered with, a sound pat will often result, whilst another pat of the same cement, if placed in a tank to set where briquettes or other pats are being constantly taken from or put into water, will show disintegration of its surface.

Sometimes, again, if a prepared sample of cement is made up into two pats and one of them be shaken down and the surface trowelled, this one will crack in the cold plunge test; while the other sample of the same cement made into a pat by merely cutting into shape with a trowel, and receiving no trowelling on the face, will, under the cold plunge test, be perfectly sound. This result of trowelling is seen in a more aggravated form in some cements than in others, either as briquettes or as pats. It is noticed that the "skin" or "scum" on the surface will separate if there has been much trowelling, whilst if there has been none the surface will remain perfectly sound. This defect again—clearly distinguishable from the cold plunge test crack—very commonly occurs where excess gypsum has been added to the cement, and if a scientific explanation be sought, the defect might be attributed to the action of sulphur compounds which exist in greater quantity in the skin than in the body of the cement block or pat. This the author has demonstrated by direct experiment with small additions of gypsum to different cements, when it was found that ultimately, in the majority of cases, with excess

gypsum, a time was reached when the skin of a shaken or trowelled pat or briquette would part from the body when placed in water after setting. In interpreting the result of a cold plunge pat test, therefore, careful regard should certainly be paid to the ascertained effects of trowelling the surface of the cement pats, for cracking caused by over-trowelling can be readily distinguished from cracking caused in other ways. In the case of a well-trowelled pat the uplifting skin is seen to be much denser than in a pat made from the same cement, and not trowelled.

It will sometimes be seen, then, that (apart from the immediate immersion test) in a freshly-made well-trowelled pat, the skin will be denser than that of an untrowelled pat, and water will work its way through this skin whilst the cement is setting and cause it to expand slightly and lift in so doing, and thus separate from the body of the pat in which the expansion caused by infiltrating water would be much smaller. From other observations made in this direction, it appears that the difference between the cracks occurring on untrowelled pats under the cold plunge test, and those on pats which have been over-trowelled, is that in the former a somewhat general but slight disintegration of the whole pat takes place, resulting in fine cracks on the surface, and the cement is friable and does not set quite hard; but in the over-trowelled pats a thin skin appears on the top of the pat, and this alone disintegrates whilst the pat itself remains sound and hard.

In all these cases the Portland cements which have been tested have readily withstood all the recognized and standard tests for soundness, strength, etc., including the 5-millimetre limit of expansion in aerated cements allowed by the Le Chatelier method.

In summarizing the author's experience of the cold plunge test, therefore, it would appear that as a broad general rule only slow-setting cements are affected by the cold plunge tests, and this without the quality of the cement being called into account. In this test defects might be separately or collectively occasioned by:

(a) Under or over-burning of the clinker, which may in turn be due to under or over-liming in the raw materials, or to the inefficient grinding or mixing in the first stages of manufacture.

(b) The setting time of the cement, or the amount of gypsum used to regulate such setting.

(c) The amount of water used in gauging the pat.

(d) The over-trowelling of the pat in preparation for the test.

(e) The temperature of the water in which the test is taken.

(f) The disturbance of the water into which the pat is placed, and the amount of alkaline matter in such water.

Of these many causes of failure it may be said that only the first has any bearing upon the actual value of the cement as a commercial and engineering commodity. Even as an index of over-liming or under-burning the cold plunge test is not a reliable one, as it has often been noticed that cement which has been passed as thoroughly sound in this test was not merely unsound, but completely disintegrated when subjected to the boiling test.

In the opinion of the author, therefore, based upon the results of many experiments, the cold plunge test is in no way to be relied upon as determining the qualities of cements, since many quick-setting cements under certain circumstances obtain a mechanical strength immediately after gaging, and therefore pass the test, whilst a slow-setting cement, which may be of a much higher quality, does not gain this mechanical strength, and, consequently, often shows signs of disintegration

in the cold plunge test. At best this test appears to afford merely a rough indication of the comparative hydraulicity of different cements, and its results being affected in the various ways indicated in the paper are no guide in determining quality.

THE FISHER POWER TAMPING BLOCK MACHINE.

The illustration which appears in the advertisement of the Fisher Hydraulic Stone and Machinery Co. in this issue is the latest type of a power concrete block machine, and by its use the mortar is rammed by heavy hydraulic pounding displacing the air and bringing together the aggregates as one unit. Water is necessary to the crystallization of cement and it is necessary to use some power that will bring the aggregates together, permitting the cement to bond them. Many efforts have been made and many structures have proved unsatisfactory for the reason that this was not done.

The initial set begins soon after the mixing of the cement and water together, extending from two to four hours and in this time the silicates are formed and the strength and imperviousness of the stone depends largely on this early crystallization of these silicates. The quantity of water must be right. Too much is as bad as not enough. The correct amount of water is between a semi-wet mix and a pouring mix, called a plastic mix, which complies with all the specifications of architects and engineers.

Now this hydraulic ramming of a plastic mixed concrete brings the aggregates together into close union thus attaining the necessary density and obtaining crushing strength and a small percentage of absorption of water.

This system is not new as for years the inventor of this machine has had before the public a powerful ramming hydraulic press, and the quality of the product has never been questioned. But the expense of manufacturing this machinery and equipment has placed it beyond many who desired to use it and to the production of machinery that could be adopted and used by those desiring a true concrete, the inventor has given much thought. His system and machinery should be carefully investigated with a view to ascertain if it does produce a product with these qualities, placing the concrete block at the head of the building product of our country.

The machinery spoken of is driven by a 2-plunger hydraulic pump, and on the gauge is registered the power of the blows, which are sufficient to displace the air. Around the center strain rod is pinioned a table mounted on wheels, and on this table are fastened three mold boxes, that rotate from the filling table to the press, to the delivery, and then again to the filling table, permitting the three mold boxes to be in operation all at the same time, one receiving the load, one being pressed, and one unloading, the operation requiring about one minute. Two men are sufficient to develop a large production of concrete blocks in a day's work.

The mold boxes are so arranged as to make a face either down or up, any style of one or two-piece solid, hollow or angular block. Any designed face pattern can be used as the delivery is made by bringing the front side over, turning the block on its side, resting on the pallet. When removed it frees itself from the pattern, making a convenient and easy operation outfit with a capacity suitable to its location and demand.

The inventor of this machinery has given great

thought combined with his knowledge to the production of a dense concrete by hydraulic ramming, and to the perfecting of a machine to meet all the demands of the concrete block manufacturer. He would be pleased to give any information regarding this machinery to those desiring it. Ask for a catalogue of the Fisher Hydraulic Stone and Machinery Company, 26 Builders Exchange Bldg., Baltimore, Md.

ANNUAL MEETING OF PENINSULAR PORTLAND CEMENT CO.

The annual meeting of the stockholders of the Peninsular Portland Cement Company was held at Jackson, Mich., a few days ago. President Cowham called the meeting to order, with about fifty stockholders present in person, whose votes, in addition to the representation by proxy, amounted to about nine-tenths of the total number of shares outstanding. The annual financial statement was submitted and unanimously approved. It shows that the company is in good condition, and that it has a large sum of surplus and undivided profits, which is mainly invested in substantial improvements to the plant and in its business.

Mr. Cowham in his remarks to the stockholders called attention to the fact, as shown by the reports of the various years during which the company has been in business, that it has paid large sums to the stockholders in dividends, and has at the same time added about 60 per cent to the value of its property. Notwithstanding the low price at which cement has been sold in 1909, a dividend was paid from the earnings. With the prospect of better prices for the present year he looked for still better results. He was generous in his praise of the employees who had worked hard and faithfully to bring about such results, even in a time of general depression and low prices, and also of the directors and stockholders, who materially aided and encouraged the management by their loyalty and harmonious efforts for the company's welfare. The board of directors was unanimously re-elected, and all the officers of the company were re-elected to their respective positions. After passing a vote of thanks to their officers, directors and employees, the stockholders of the oldest company of the successful group of mills widely known as the "Cowham System of Portland Cement Mills," adjourned in accordance with their annual custom, to enjoy a good dinner at the Otsego hotel. The officers and directors for the ensuing year are as follows:

W. F. Cowham, Jackson, Mich., president and general manager.

D. C. Griffin, Ypsilanti, Mich., vice-president.

N. S. Potter, Jackson, Mich., treasurer.

John W. Shove, Jackson, Mich., secretary.

H. Frank Stone, Rochester, Mich., director.

H. R. Scoville, Ypsilanti, Mich., director.

John B. Holthouse, Decatur, Ind., director.

F. E. Palmer, Jackson, Mich., director.

W. W. Hawley, Huntington, Ind., director.

CONCRETE CULVERTS AND BRIDGES, ONLY, FOR KANSAS.

Kansas should not hesitate to follow the advice of its state engineer of highways, W. S. Gearhart, who urges that the tin bridges recently destroyed by the ice gorges be replaced with permanent concrete structures.

The interesting information that in many of the counties more than one-half the road fund is invested in the maintenance and construction of bridges and

culverts is the answer to the question as to why Kansas has bad roads. The waste involved in bridges and culverts that are at best but temporary affairs explains the depletion of the road tax levy without any perceptible improvement in the highways themselves. The life of the average wooden bridge, as pointed out by Mr. Gearhart, is four years. Along the streams where extraordinary freshets are likely to occur at any time, the life of these temporary structures is limited to the probability of the regular annual overflow.

When men of sound business judgment invest capital in private enterprises of that character they build against the possibility of its destruction by storm or flood. They invest their money in improvements that will endure, so that it will not be necessary for them to reckon that investment as liable to be lost at any moment.

Public funds should be invested by the same rule. When bridges and culverts are built they should be constructed upon a foundation and of material that will stand for fifty years instead of four years. The difference is the cost of a tin or a timber bridge and a concrete bridge is so small as to leave no excuse for the temporary structure save that of stupid neglect of the public interest. In Kansas, where public spirit and enterprise have characterized the development of the state, there should be no tolerance of the makeshift policy of wasting public funds in 4-year bridges.

Mr. Gearhart has started a movement in Kansas that should unite in its support, every enterprising citizen and community in the state.

CONCRETE VS. TERRA COTTA TILE.

In a recent lecture before the real estate class of the Y. M. C. A., New York, G. Richard Davis, of the firm of A. L. Mordecai & Son, took up the subject of hollow terra cotta tile vs. concrete in building construction. His lecture was induced by a provision in the proposed building code excluding the use of cinder concrete. Mr. Davis said, in part:

"The dead weight of an arch built of terra cotta tile laid in cement mortar is considerably greater than the dead weight of an arch built of cinder concrete mixed with cement mortar. This is due to the greater weight of the terra cotta per cubic foot and also to the fact that a four-inch concrete slab will sustain as much weight as an eight-inch terra cotta arch. To carry the increased dead weight that the use of a terra cotta arch creates if substituted for a cinder concrete arch, the steel work of a building must be made heavier. In other words, a building will cost more when terra cotta is used for the arches than when cinder concrete is used, due to the increase in weight of the steel.

If the terra cotta tile arch were freed from competition with the cinder concrete arch, which at the present time it cannot commercially compete with, the manufacturers of terra cotta tile would be enabled to increase their price instead of reducing it, as they are now obliged to do to meet competition.

It is to be hoped that a clear understanding of the situation by those who will decide this question in our city government will enable us to obtain a building code which will admit of fair competition for all classes of fireproof arches which give equal results, no matter what the cost of one may be as against the other.

MAKING CONCRETE SEWER BENDS.

A Vancouver man has invented a machine that will be welcomed by contractors who have used concrete sewer pipe and have been unable to mold sections for turning corners. Y-joints and T-joints may be made from straight pipe, but up to the present time no machine has been on the market for making radial sections.

R. L. Rickman, 987 Westminster avenue, Vancouver, B. C., manufactures a machine for making this kind of pipe, advertised on another page of this number of Cement & Engineering News. It consists of a frame bearing a portable mold and a tamper and core working on the same radius. When the machine stands, as in the illustration, a shovel of concrete is placed in the hopper and is fed little by little into the pipe mold around the core. The material is tamped in by pressing the foot lever that operates the tamping ring. When the mold is full the bell form is set on and enough material added and tamped to complete the section. The core is then released, withdrawing from the bottom, the hopper raised, and the pipe is carried to a pallet, where it is placed and the mold released from it. Mr. Rickman says that one man can make from fifteen to twenty bent sections per hour on this machine, which is sure to meet with instant favor among manufacturers of concrete pipe and tile. The manufacturer issues some interesting circular matter on the concrete sewer pipe business, which will be sent free to readers of this paper who are interested.

CEMENT MILL NEWS.

A. Baumberger, who was connected with the Kansas City Portland Cement Company for years as sales-manager; and after that company was sold to the Union Sand and Material Company of St. Louis, he continued in the same capacity with the latter company; has accepted the position as sales manager of the Lumbermen's Portland Cement Company, of Kansas City. This company will have their plant in operation within the next few weeks, and when completed it will be one of the best in the Central Western states. The Lumbermen's Portland Cement Company has contracted for the output of the new plant at Cape Girardeau, Mo., as well as the output of the Bonner Portland Cement Company.

Dallas, Tex.—At the annual meeting of the stockholders of the Southwestern States Portland Cement Co. stockholders were present from Texas, Kansas, Iowa, Minnesota, South Dakota, Indiana, Michigan and other states, and nearly all of the stock was represented in person or by proxy.

The financial statement of the company submitted by the board of directors shows that the plant is operating profitably and the company is in good financial condition. The members of the old board of directors were unanimously re-elected. The officers and directors are as follows: W. F. Cowham, president and general manager; A. C. Stich, first vice-president; Thomas H. Dinsmore, second vice-president; W. H. L. McCourtie, secretary; John W. Shove, assistant secretary; N. S. Potter, treasurer; Dr. C. H. Wagner, J. H. McNair and W. W. Hawley, directors.

* * *

Hannibal, Mo.—Plant No. 5 of the Atlas Portland Cement Co., after having been closed down for several weeks on account of a shortage in coal supply, has been reopened and 300 new men put to work. The force will be increased gradually until about 800 men have been employed. The cement plant will soon

be running full blast and there will be no excuse for anyone being idle.

Plant No. 5 was recently remodeled throughout. Two new kilns, said to be the largest in the world, were installed and several other improvements were made. During the past six months nearly \$500,000 has been spent on the works.

* * *

Nazareth, Pa.—Acceptances are being obtained from stock and bondholders for a merger of the Portland Cement Co., and the Bath-Portland Cement Co.

Joseph A. Horner is president of both companies. The new organization is to have a capital of \$5,000,000, with a combined output of more than 3,000,000 barrels a year. The Nazareth company has securities amounting to \$2,500,000 and the Bath company \$1,000,000. To be included in the merger are mills in Maryland and Virginia. The combination will command southern as well as New York, Philadelphia and New England markets.

Shortly after the Nazareth mill had been established, the first to be erected in the Northampton cement region, it was bought by a syndicate of New York capitalists that included members of the Vanderbilt family. The Bath company securities are held chiefly in Philadelphia, Camden, Newark and Pittsburgh.

* * *

On February 24 death claimed W. J. Prentice, president of the Crescent Portland Cement Company, of Pittsburgh.

* * *

Several improvements in the equipment of its cement plant just north of Chanute, Kas., are being made by the Ash Grove Lime and Portland Cement Company. It is erecting a large building. New railroad track is being laid, and twenty-six cars have been added to the number used in the rock quarry. This is an increase of about 50 per cent.

* * *

Nazareth, Pa.—The Atlanta and Gulf Portland Cement Company is building a new cement plant at Ragland, Ga., and has ordered the necessary crushing machinery from Allis-Chalmers Company. This will include one No. 7½ style "K" Gates gyratory crusher, one No. 4 crusher of the same style and one No. 8 ball mill.

* * *

The Penn Allen Portland Cement Co., with works near Nazareth, Pa., has been placed in the hands of a receiver. The plant is valued at \$700,000. The United States District Court has named William E. Erdell, receiver, with a bond of \$5,000.

* * *

C. A. Morrison, Superintendent of the Three Forks Portland Cement Co., which is erecting a large plant at Trident, Mont., states that operations will commence shortly after May 1st. The plant will represent an investment of \$600,000.

* * *

The Western States Portland Cement Co., announces the resignation, on account of ill health, of T. E. McLaren who, until recently, has been in charge of the company's sales department. E. R. Stapleton, formerly with the Iola Portland Cement Co., succeeds Mr. McLaren as sales manager, with offices in the N. Y. Life Building, Kansas City, Mo.

* * *

William Turner, President of the Phoenix Portland Cement Co., died on January 27. Mr. Turner was apparently in good health up to 24 hours, before his death. On the evening of January 26, he was stricken

with apoplexy and died the following day. Mr. Turner has been President of the Phoenix Portland Cement Co., for the past 9 years, he was likewise President of the Imperial Portland Cement Co., of Nazareth, Pa., and President of the First National Bank of Pen Argyl, Pa. He was born at Hope, N. J., on February 9, 1859; he leaves a wife and three children.

* * *

Seattle, Wash.—In addition to the electrical apparatus already installed, the Superior Portland Cement Company, of Seattle, Wash., has also placed an order with Allis-Chalmers Company for a 250 K. W. 3 phase, 60 cycle, 600 volt, 600 r. p. m. belt driven alternator and a 9 K. W., 120 volt exciter for the same.

* * *

Edward Hennessy, for a number of years the western representative in Chicago for the Alpha Portland Cement Company, was promoted to the position of sales manager at Easton, Pa., last January. V. Richter, his assistant, is now running the Chicago office. Speaking of the conditions in the cement trade he said: "The demand in the west for cement this year will be greater than has ever been experienced before. Prices are advancing and an unusually active season is beyond a question of a doubt before us. Everything is looking very bright."

* * *

H. E. Newby, formerly in the traffic department of the Kansas City Portland Cement Works at Kansas City, Mo., is now general sales manager of the Great Western Portland Cement Company of that city.

* * *

The suit of A. Carpentier, of San Francisco, against W. P. Fuller & Co., of Los Angeles, to recover the value of 35,000 barrels of cement, has been settled without an appeal to a higher tribunal, after the court had decided against the plaintiff, who is to pay costs. The case grew out of a contract whereby Carpentier was to deliver about 100,000 barrels of cement, of which 35,000 barrels were rejected on the ground that it was not up to specifications and not merchantable. Carpentier contended that the defendant was to blame, having kept the material in a damp place.

* * *

The Riverside Portland Cement Company, of Los Angeles, has contracted with the city of Los Angeles to supply 72,000 tons of crushed rock for road improvement at 70 cents per ton. The Riverside Portland Cement Company recently signed a contract with the Los Angeles Aqueduct Board for 100,000 barrels of cement for rushed work on the Owens River aqueduct.

* * *

In the railroad rate controversy at Philadelphia, Cyrus W. Borgner pointed out that from investigations it was shown that the \$1.35 rate charged to this city from the Northampton-Lehigh district is out of all proportion with rates from other cement fields. In support of his statement he said that the Security Cement Company ships products from the mills at Hagerstown, Md., to Baltimore, a distance of 87 miles, for 85 cents a ton. This is a longer haul than from the Northampton district to Philadelphia.

The Tidewater Portland Cement Company ships from its plant at Union Bridge, Md., to Baltimore, a distance of 45 miles, for 35 cents a ton. From Craigsville, Va., to Washington, a distance of 176 miles, the railroads carry cement for \$1.50 a ton. From the same plant to Norfolk, a distance of 243 miles, a charge of \$1.25 a ton is made, while to Baltimore, a distance of 216 miles, the freight is \$1.80.

Work has begun at Mason City, Iowa, on a mammoth storehouse to be built by the Northwestern States Cement company, at their plant for storing the finish product for use during months of the year when the factory cannot be operated at full capacity. The building will be made of reinforced concrete, over 400 feet in length and will hold over 600,000 barrels of cement. It will have a hopper bottom.

NEW CEMENT MILLS.

According to the present plans of the St. Mary's Portland Cement Co., St. Mary's, Ont., work will be commenced early in the spring on construction work. The proposal is to employ about one hundred men. A large sum of money will be expended on the new work. The company is arranging for 1,000 horsepower and are now completing plans and final arrangements in order to rush the work on the building and plant. The interests of the company are in charge of Dr. J. McNally and Mr. J. G. Lind, of Owen Sound.

* * *

Notice is given of the incorporation of the Central Canada Portland Cement Co., Limited, with a capital of \$1,000,000 and head offices in Winnipeg. The directors named in the charter are William A. Fox, merchant; Valdimar J. Melsted, mining engineer, both of Minneapolis; Charles Blake, Leonard Cashmore and Henry F. Tench. The company is vested with all the powers necessary for the manufacture of cement.

* * *

The annual meeting of the Sun Portland Cement Co., took place recently at Owen Sound. The directors'

report and financial statements showed the company to be in a prosperous condition, and the prospects good for the coming season. The officers and directors were re-elected. The question of enlarging the capacity of the plant and making alterations to adapt it to the manufacture of rock cement were discussed. All present at the meeting appeared to favor the proposition, but no action was taken. It was decided to refer the matter to the directors. A special meeting to discuss the matter will shortly be held.

* * *

The Vancouver Portland Cement Co., whose quarry and plant are situated at Todd Inlet, Vancouver Island, have just installed a new rock crusher of sixty tons hourly capacity. The machine was purchased from Allis-Chalmers-Bullock, Limited, of Vancouver. This addition to the company's plant will almost double the former capacity.

* * *

New York, N. Y., March 10.—William F. Allen qualified today as receiver for the Seaboard Cement Company and the Atlantic Cement & Clinker Company, by filing in the United States Circuit Court a bond for \$50,000. He was appointed in a bondholders' suit, brought against the companies by George A. Beaton of Plainfield, N. J., and others.

This litigation is preliminary to a reorganization, and was taken to protect the assets of the Seaboard Portland Cement Company of No. 225 Fifth avenue and Alsen, N. Y., which are estimated at more than \$1,000,000. The liabilities outside of the bond issue of \$2,000,000 are not large. The company was incor-



The above illustration is a view of the ruins of the Tosa Portland Cement Company's plant at Kochi, Tosa, Japan., which was destroyed by fire last June. It is now being rebuilt and will be in operation by May first. The gentlemen shown under the cross is Yeichi, Niina, the manager and superintendent of the plant.. Mr. Niina is a very bright young man of ability, above the average.. He is only 30 years of age and received his training in cement mills in the United States, particularly at the Lehigh and Sandusky mills and he is well known in this country.

porated in this state in 1907, with an authorized capital of \$5,000,000.

It bought 700 acres of land at Catskill, N. Y., and it was stated last December that \$300,000 additional would be required to complete the plant. The Atlantic Cement & Clinker Company, said to be controlled by the Seaboard Portland Cement Company, is a Delaware corporation.

The receivership is said to be in the interests of a proposed merger with the Compania Cubana de Cementa Portland and the Atlantic Cement & Clinker Company, to operate in Cuba, West Indies and Central America.

* * *

Announcement has been made that the Lake Shore Portland Cement Co., of Sandusky, Ohio, and the Spokane Portland Cement Co., of Spokane, Wash., have had their interests merged in one concern. It is expected that this will mean the pushing forward of work on the 1,000,000-barrel cement plant at Sandusky, which was started a year ago but abandoned for the time being. Cement is to be made from marl, which is found in abundant quantities in the neighborhood of Castalia, where the company owns many acres of land.

* * *

In addition to the machinery ordered some time ago from Allis-Chalmers Company for the new plant of the Clinchfield Portland Cement Company, Kingsport, Tenn., additional contracts have recently been made with the same company for three 5'-6" x 22" tube mills. These will be motor-driven by Allis-Chalmers motors.

Wichita, Kan.,—A new Portland cement company is being organized and the headquarters and general offices are to be in Wichita.

Wichita capital is interested in the new enterprise. Among the Wichita directors will be George T. Walker, of the Jackson & Walker Coal & Material Company, and George H. Parker, of the same company.

The name of the new company will be the Arkansas City Portland Cement Company. Its factory will be located at Arkansas City, Kan. Large quantities of natural material for the manufacture of Portland cement abound at Arkansas City.

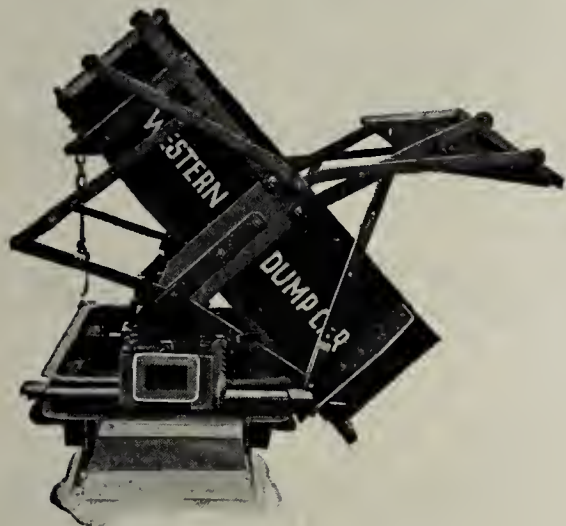
The capitalization of the new company will be \$750,000 and the sale of stock is progressing rapidly. Mr. Walker, in speaking of the new company, said today:

"We are aiding in the construction of this new enterprise because it brings a first-class Portland cement company within an hour and a half ride of Wichita.

"This factory will be of interest to every man interested in building material because it will give him a first-class product on a shorter haul and make a great saving in freight. It will be observed from the amount of the capitalization that no provision has been made for great profits on the sale of stock. The money received from the stock is to be used to build the mill.

"The property of the Arkansas City Portland Cement Company is unsurpassed in the production of cement material and the location is ideal. The new company will be a great success.

WESTERN DUMP CARS



1½-yd. Car in Dumped Position

For handling cement, sand, strippings, etc., economically, there is nothing that can compare with the Western Dump Cars. They are made in all sizes from 1¼ yard on 2-ft. gauge, up to the heavy double truck railroad cars on standard gauge.

The low lift for the shovellers, the steep dumping angle, automatic side boards, high quality of material used in their construction, are a few of the many points which make the Western unequalled.

Western Wheeled Scrapers
Western Fresno Scrapers
Western Elevating Graders
Western Dump Carts

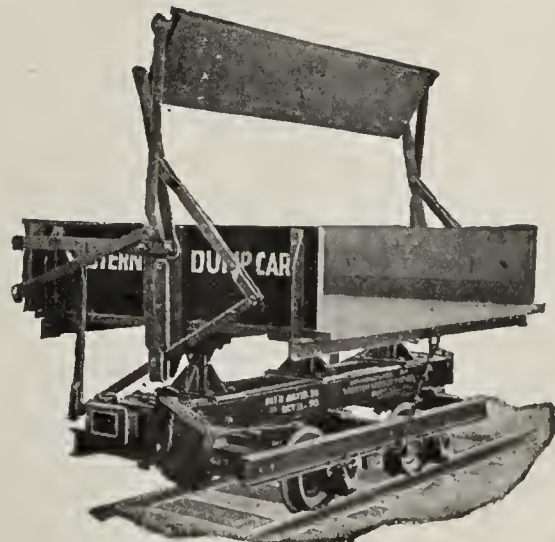
Western Drag Scrapers
Western Railroad Plows
Western Road Graders
Aurora Rock Crushers

Aurora Dump Wagons

Send for Catalog of Earth and Stone Handling Machinery

Western Wheeled Scraper Co.

Aurora, Illinois



1½-yd. Side Dump Car with side board raised ready for loading by hand.

GLIDDEN

GLIDDEN'S LIQUID CEMENT

Uniforms the color of Concrete-Cement and Plaster surfaces, producing a waterproof result.

Made in Sandstone finish and several shades along the lines of Colonial and Pompeian Buffs.

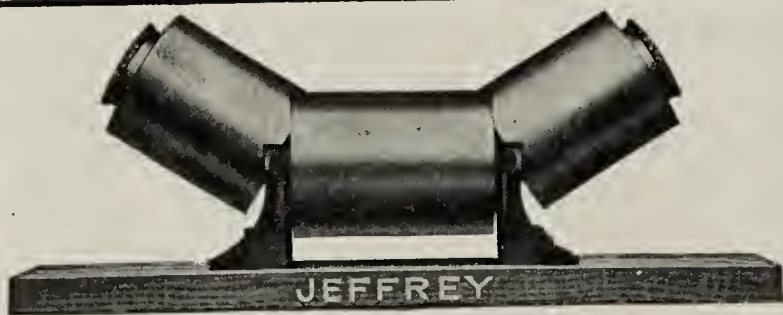
Inexpensive and easily applied.

Samples and full information gratis upon request.

A product of The Glidden Varnish Company, exclusively.

The Glidden Varnish Company, CLEVELAND
OHIO

GLIDDEN



JEFFREY RUBBER BELT CONVEYERS

Are the most efficient—Last longer and Cost less for up-keep than any other make.

We are prepared to quote very attractive prices on equipments for all purposes

LET US FIGURE WITH YOU

WE BUILD

{ Elevating and Conveying Machinery to suit all conditions.
Coal and Ashes Handling Systems for Power Plants.
Excavating and Screening Machinery, Crushers, Dump Cars, etc.

SEND FOR CATALOG Aa51

The Jeffrey Mfg. Co., Columbus, Ohio

NEW YORK
CHICAGO

ST. LOUIS
BOSTON

DENVER
PITTSBURG

MONTREAL, CAN.

Limestone and Shale

FOR MANUFACTURE OF

Portland Cement

ON THE

Illinois Central Railroad

IN THE

West and South

Coal, Water and Good Labor

For Full Particulars Address

J. C. CLAIR,

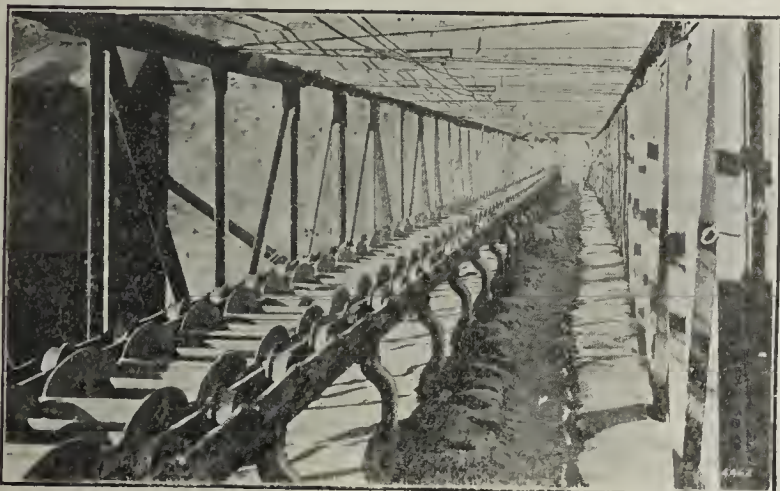
Industrial Commissioner, I. C. R. R. Co.

1 Park Row - Chicago

PECK CARRIER

THE STANDARD MACHINE
FOR HANDLING

Cement, Crushed Rock,
Hot and Cold Clinker,
Coal, Etc.



PECK CARRIER For Cement.

Union Portland Cement Co., Devil's Slide, Utah.

Full particulars of the Carrier's Construction, by which horizontal conveying position is assumed and resumed without the necessity of overturning the buckets, is explained in our book No. 81. Write to us for copies.

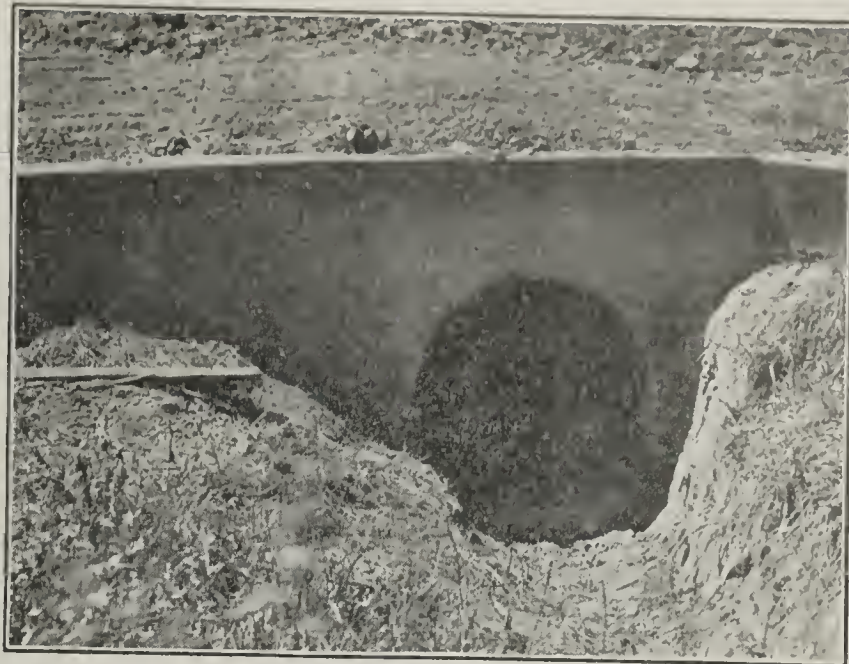
LINK-BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

NEW YORK, 299 Broadway. PITTSBURGH, 1501-2 Park Bldg. ST. LOUIS, Central Nat'l Bank Bldg.

SEATTLE, 439-440 New York Block DENVER, Lindrooth, Shubart & Co.

NEW ORLEANS—Wilmot Machinery Co.



CONCRETE CULVERTS

will soon replace all other kinds of Culverts, because they are comparatively cheap and practically indestructible, while other Culverts are but temporary and must soon be replaced.

The Merillat System

of building concrete Culverts is the cheapest and most satisfactory.

The Merillat Adjustable Core

is not only collapsible like other Culvert forms, but is adjustable to positively any size between 20 and 48 inches. It is entirely automatic and at any size is braced, locked and round.

This means one form and therefore one investment for all your Culvert work. Why buy a form that makes but one size, when ours which makes every size costs no more?

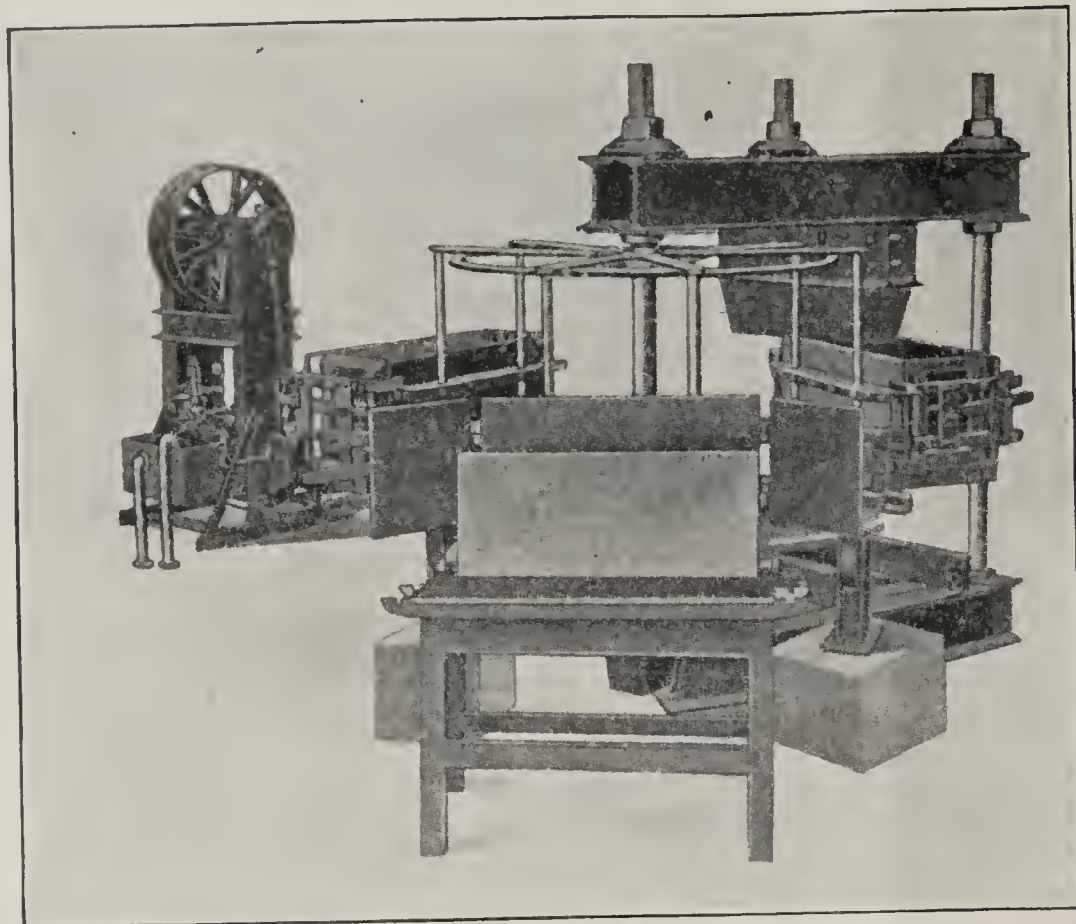
GET OUR CATALOG

The Merillat Culvert Core Co.

400 RAILROAD STREET

WINFIELD, IOWA

A DENSE CONCRETE



A Hydraulic Ram Pounding Concrete Into Blocks

TWO MEN do the work. From 1000 to 2000 blocks per day. Three quick-acting mold boxes rotating over the Ram on a Revolving Table, one being filled, one receiving the pounding, one delivering the finished block.

The Fisher Hydraulic Machine pounds a wet mixed mortar together with a Hydraulic Ram and produces a dense concrete with less than 5% absorption, with a high crushing strength, in any style to suit the demand.

Ask for Catalogue or any information regarding our system.

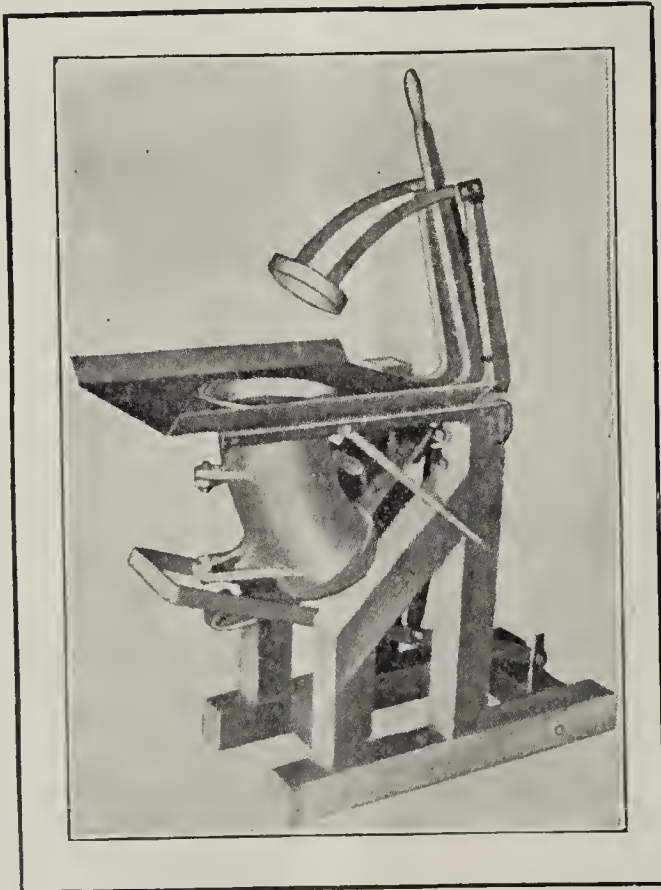
Fisher Hydraulic Stone & Machinery Co.

Builders' Exchange Building, Baltimore, Md.

Concrete Sewer Pipe Bends

The Only Machine
of Its Kind
on the Market.

Concrete Sewer Pipe
Bends Made on the
**RICKMAN SEWER PIPE
BEND MACHINE** Make
Money for the Manu-
facturer.



The Latest Thing
Added to the Concrete
Machinery Line.

ONE MAN can make from 15 to 20 curved sections of pipe per hour. Shovel in the material, tamp it with the tamping ring, operated by foot lever, attach the bell-end form, complete the section, withdraw core from below, by lever, carry the pipe away to a pallet and bring the outer mold back to the machine.

You Need This Machine to Complete the Equipment of Your Tile Factory

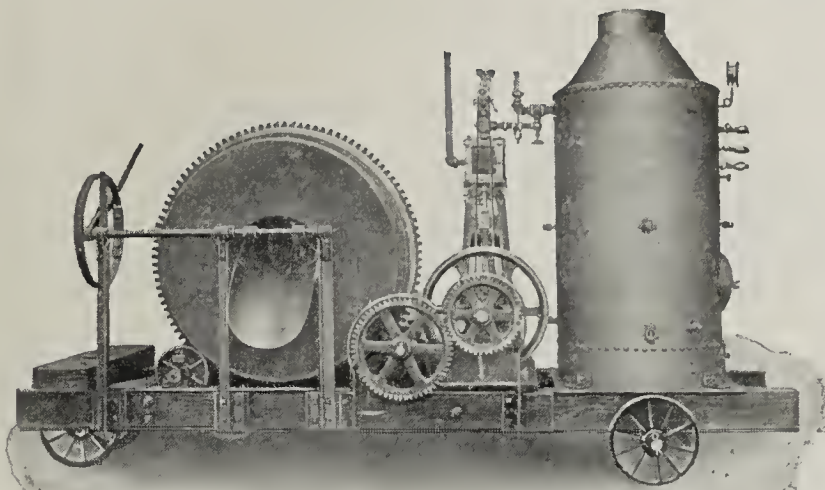
Write for Circulars and Prices

R. L. RICKMAN CO.,

987 Westminster Avenue,
VANCOUVER, B. C.

Ransome Efficiency

*Direct from
Drum to Cars,
Buckets, Carts
or Wheelbarrows
Without Tilting*



Ransome Mixer with chute in discharge position.

Saves Time In Discharging

¶ In selecting a Concrete Mixer, never mind the "Talking Points." You expect actual, bona fide, *demonstrated efficiency!* You want, not only a thorough mixture of concrete, but also a quick handling of the loose materials and the mixed concrete. You should demand the *maximum concrete output* at the *minimum operating cost!*

¶ In truth, you have but little choice; if you buy a mixer as you hire a man, for steady reliability and the amount of work he can do, then you will, of necessity, buy a Ransome. 50 to 70 batches per hour is a common proof of Ransome Efficiency. 37 batches per hour *all day long* is a demonstrated, practical, *working average.*

¶ The Ransome is a *great economizer of time* in getting materials to the mixer and concrete to the place of deposit.

¶ The Ransome discharges direct from drum *without tilting*; and, being non-tilting, it needs no room for clearance, hence can be mounted *at least 50% lower* than any tilting mixer. The steeper the hill, the longer it takes to climb it; and, the higher the charging platform, the fewer wheelbarrow loads get to the top in the course of a working day, or—the more men it takes to get them there. *Use a Ransome and save wages!*

¶ The Ransome is furnished with Pivot Charging Hopper, Skip Bucket Side-Loader, Gravity Batch Hopper or regular Charging Chute and is equipped with steam, gasoline, electric motor or belt drive. *There is a Ransome Mixer for every mixing condition, each equipped for the exact requirements of the job.*

Start your job right! Tell us your conditions and we will suggest the machine best suited for you; *anyway*—send for Booklet "*In the Wake of the Ransome.*"

William B. Hough Company

"Where the Good Contractors' Machinery Comes From"

*Large Stock carried in
our Chicago Warehouses*



*Monadnock Building
Chicago, U. S. A.*

BIG MONEY FOR YOU

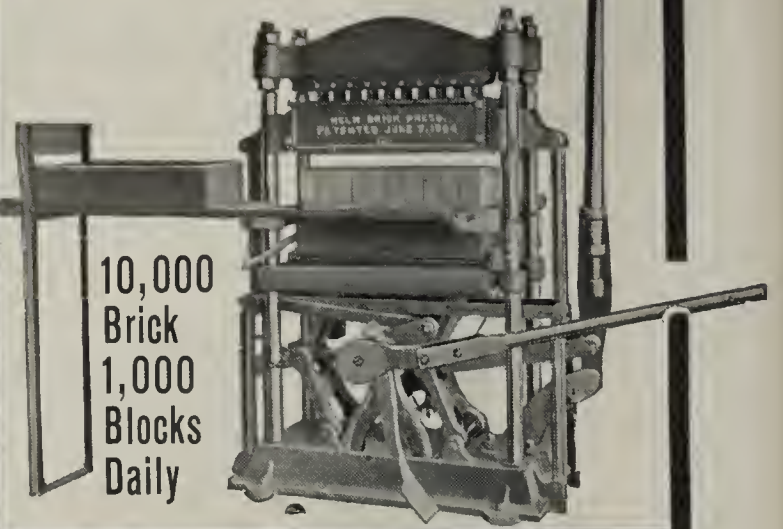
In Pressed DRY-WALL Blocks and Brick

Helm Presses make as high as \$50.00 daily. You can secure the cream of the concrete business with their superior product. Unequalled for beauty, strength, adaptability and cheapness. Daily displacing machines of every description.

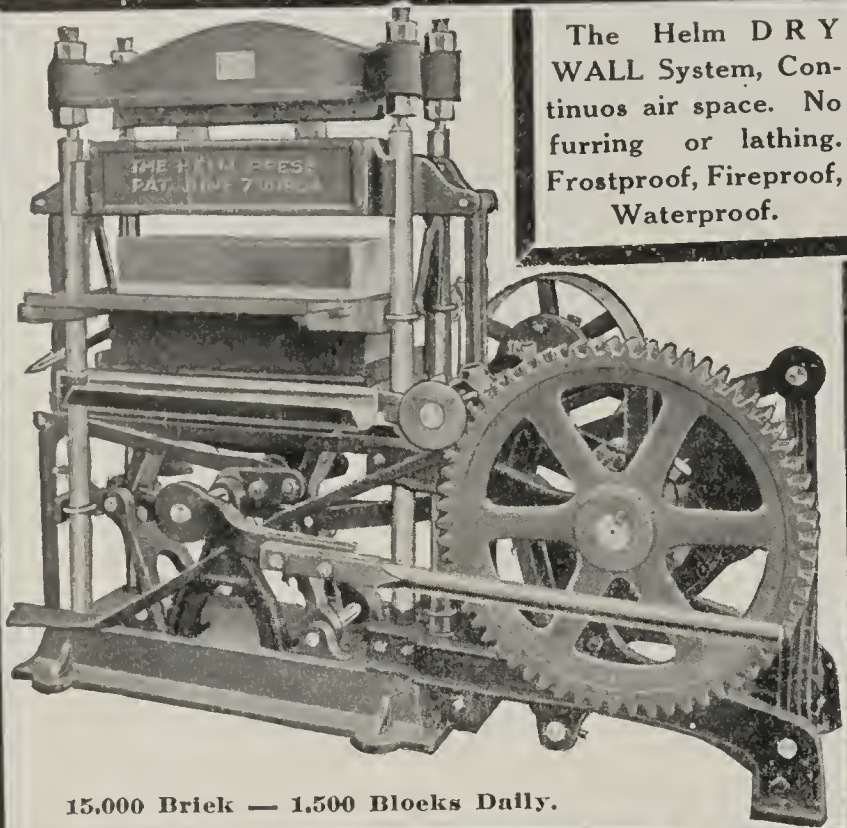
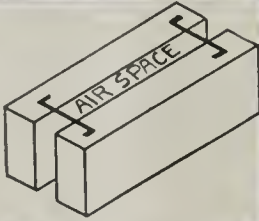
The 80,000 lbs. pressure of Helm Brick and Block Presses make the strongest and most uniform concrete product. A 6 to 1 brick only 27 days old stood 85,000 pounds compression, for excelling all other tests. Heavy pressure on medium wet concrete secures this wonderful result with the least cement. A Helm Press and the medium wet mix is the only sure and certain method. You're bound to adopt it in the end. You'll save money by adopting it now. No "extras" to buy with Helm outfits.

80,000 lbs.
Pressure

10,000
Brick
1,000
Blocks
Daily



The Helm DRY
WALL System, Con-
tinuous air space. No
furring or lathing.
Frostproof, Fireproof,
Waterproof.



15,000 Brick — 1,500 Blocks Daily.

Investigate the Helm Hand and Power Presses

if you want to control the big contracts in your locality. You can outstrip competition. You can manufacture cheaper, make better product and get better prices and more business.

Send the Coupon for free Concrete Book

Profusely illustrated with half-tones and diagrams of machines, product and building forms. Shows how to secure dry walls. Don't buy without first getting this book. Send the coupon right now for your copy, free and prepaid.

HELM BRICK MACHINE COMPANY,
214 Bank Building, Traverse City, Mich.

HELM BRICK MACHINE COMPANY,
214 Bank Bldg., Traverse City, Mich.

Send me the free book on concrete. Interested in ☐ Blocks,
Brick. ☐ Mixers. ☐

NAME

ADDRESS

PATEK'S CONCRETCOTE

INSIDE AND OUTSIDE FINISH FOR CONCRETE.

This special concrete finish waterproofs concrete, and is practical to use under all working conditions, unaffected by dampness, gases, smoke, oil, etc. Gives uniformity of color to concrete, covering joints, dirt streaks, etc. Concretcote does not crack, peel or blister.

A PERFECT, PRACTICAL STAIN FOR THE EXTERIOR OF STUCCO AND CONCRETE HOUSES.

WALLS—Wall Concretcote is the only remedy for saltpetre trouble. Recommend it and figure it on your jobs, and you will avoid the difficulties encountered when saltpetre comes in contact with oil and water paints.

FLOORS—Floor Concretcote penetrates the concrete deeply and evenly, seals the pores and amalgamates with the material, forming a moisture proof surface. Gives an elastic, linoleum-like surface, non-porous and washable, which resists the pulverizing of cement by heavy traffic.

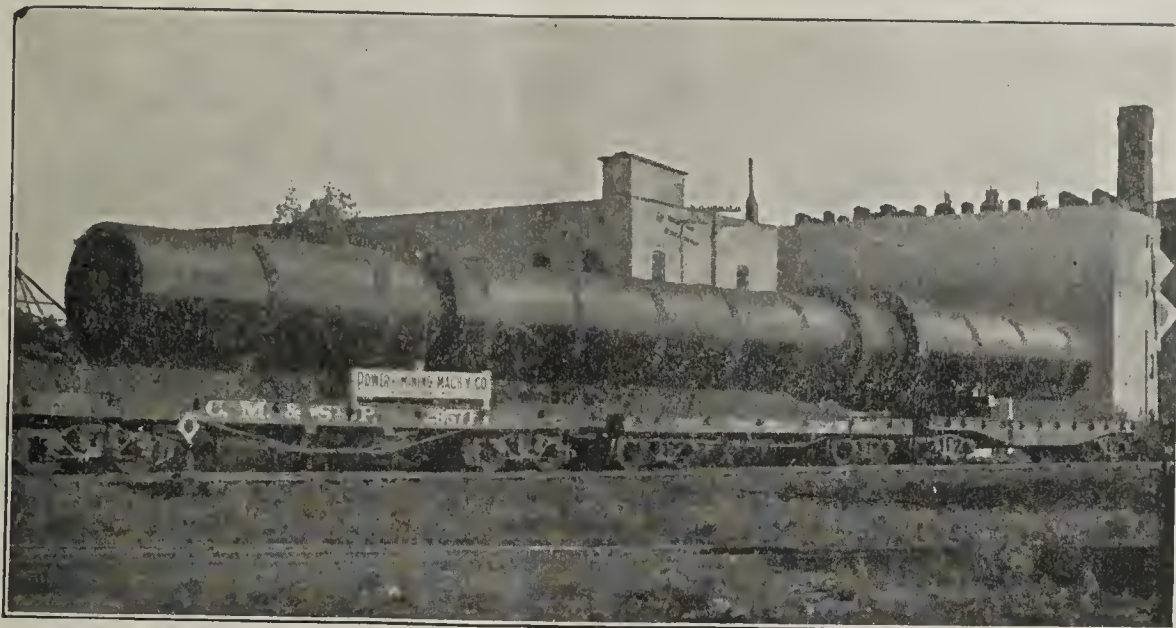
Write For Free Booklet Showing Colors.

PATEK BROTHERS, Sole Makers, MILWAUKEE.

Cement Mill Machinery

A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process,

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



Write for Catalogue No. 17.

Power & Mining Machinery Company

MILWAUKEE, WIS., U. S. A.

CHICAGO.

NEW YORK.

ATLANTA.

EL PASO.

SAN FRANCISCO.

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

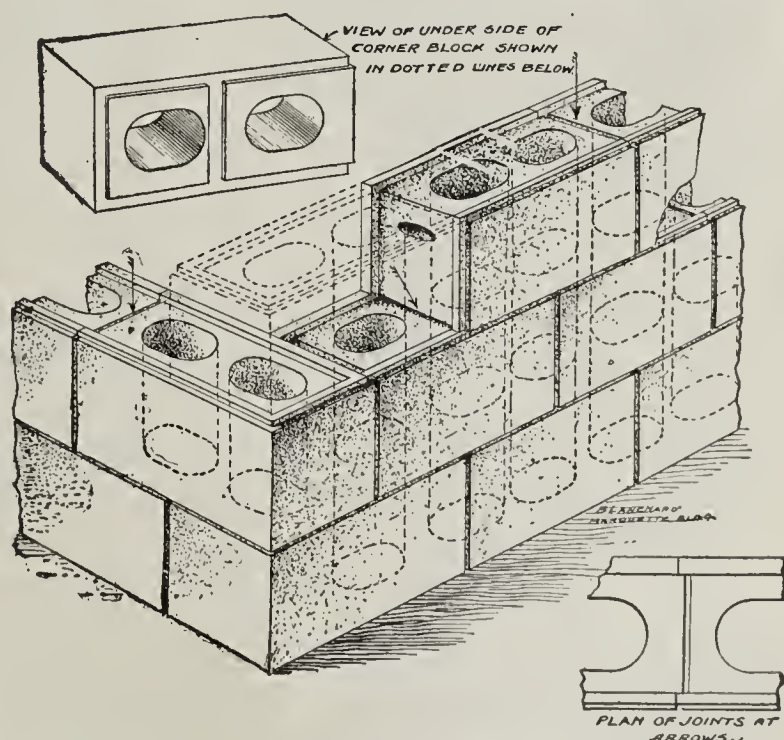
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting Face-Down Machine by the Wet Process

The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and agents wanted in all states and foreign countries.

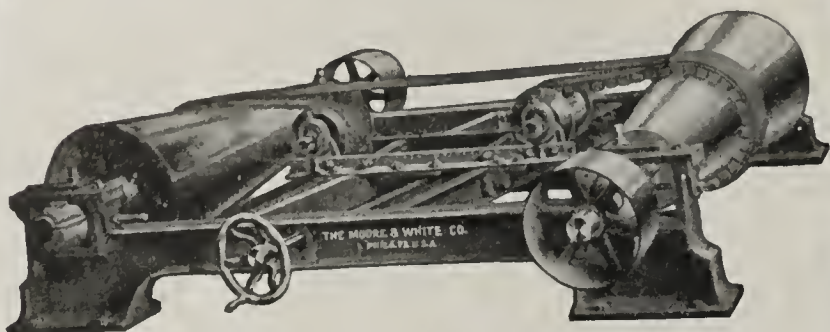


DIAMOND CONCRETE MACHINERY COMPANY

Tacoma Building,

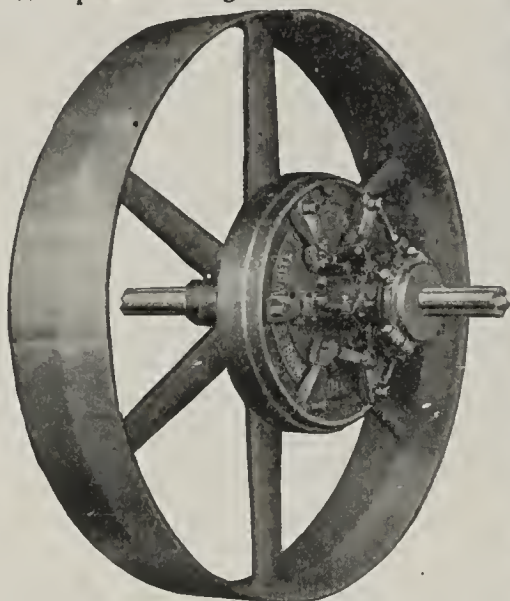
Chicago, Illinois

It will be to any Mill Owner's advantage to investigate these two economical Power devices.



M. & W. Speed Change.

Power
Transmission
Machinery
for
Cement
Mills.



Write for

Catalogue.

Friction Clutch Pulley.

The Moore & White Co.,
Philadelphia, Pa.



Universal is Uniform

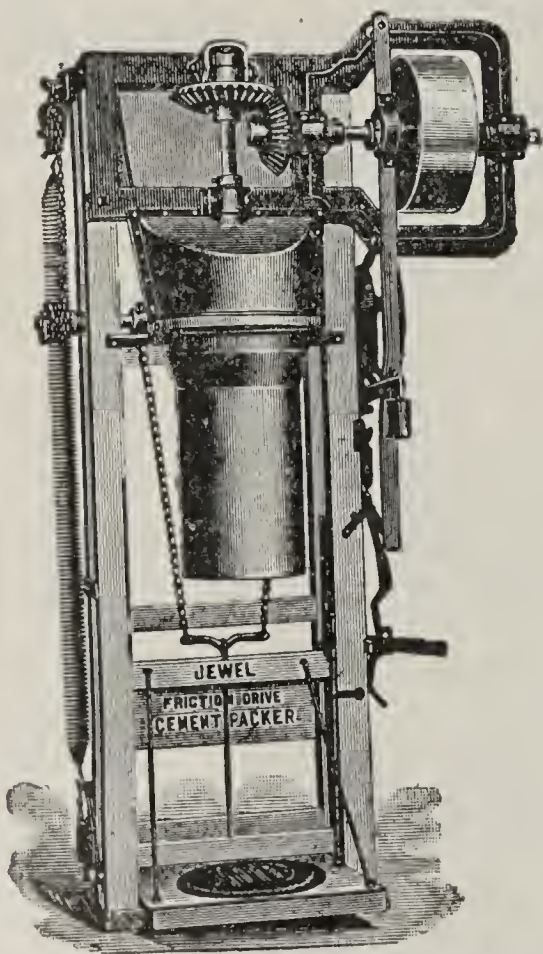
Uniform in soundness—
Uniform in strength—
Uniform in fineness—
Uniform in color—
Uniform in specific gravity—
Uniform in setting qualities—
Uniformity means superiority.

Use Universal—it produces uniformly excellent results.

Universal
Portland Cement Co.
Chicago — Pittsburg



There is more Cement being packed by the "S. HOWES" Company's Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and sacks.

The "JEWEL" FRICTION driven cement Packer, specially constructed for rapidly packing sacks.

Both machines are equipped with friction pulleys, heavy iron frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company
SILVER CREEK, N. Y.

Apparatus for Chemical and Physical Testing of Cement

EIMER & AMEND

205-211 Third Avenue, New York City

MANUFACTURERS OF & HEADQUARTERS FOR

Chemical Apparatus, C. P. Chemicals and Reagents

Cement Briquette Moulds.

Gilmore Needle.

Standard Sieves of Exact Meshes.

Williams' Sp. Gr. Balance.

*Specially adapted for determining
Sp. Gr. of Cement.*

(Descriptive Pamphlet sent on request)

*Schumann's, Le Chatelier's,
Jackson's and Candelot's
Apparatus for Sp. Gr. of
Cement.*

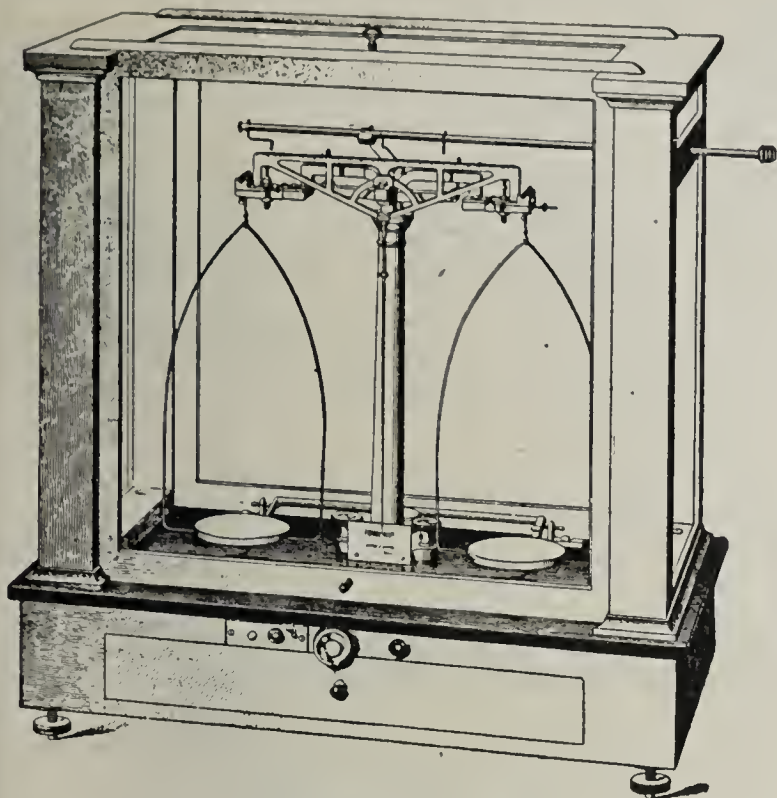
The "E. & A." Gold Plated Short Beam Analytical Balance

Capacity, 200 grm.; Sensibility, 1-20th mgr.

Perfect in Construction and Adjustment

Headquarters for **Calorimeters and Pyrometers.**

(Our large illustrated Catalogue gladly sent to Chemists on application.)



F. A. Jones, M. E.

Gypsum Specialist

Consulting Mechanical, and Chemical Engineer, in Designing Construction, and Operation of Plaster Mills, Mines, and Mixing Plants.

Plans, Specifications, Estimates of Cost, Superintendence of Construction, ROTARY OR KETTLE PROCESS.

Examination, Tests, Analysis, and Reports of Gypsum Properties, Mills Remodeled and Enlarged, Mixing Plants Erected, and Formulas Furnished.

YOUNGSTOWN, OHIO.

WM. B. SCAIFE & SONS CO.

221 First Ave., Pittsburg, Pa.

WE-FU-GO

and **SCAIFE**

Water Softening, Purifying, and Filtering Systems

— FOR —

BOILER FEED

AND EVERY INDUSTRIAL USE.

Send for Complete Information

DEXTER Portland Cement

THE NEW STANDARD

Sole Agents **SAMUEL H. FRENCH & CO.** Philadelphia



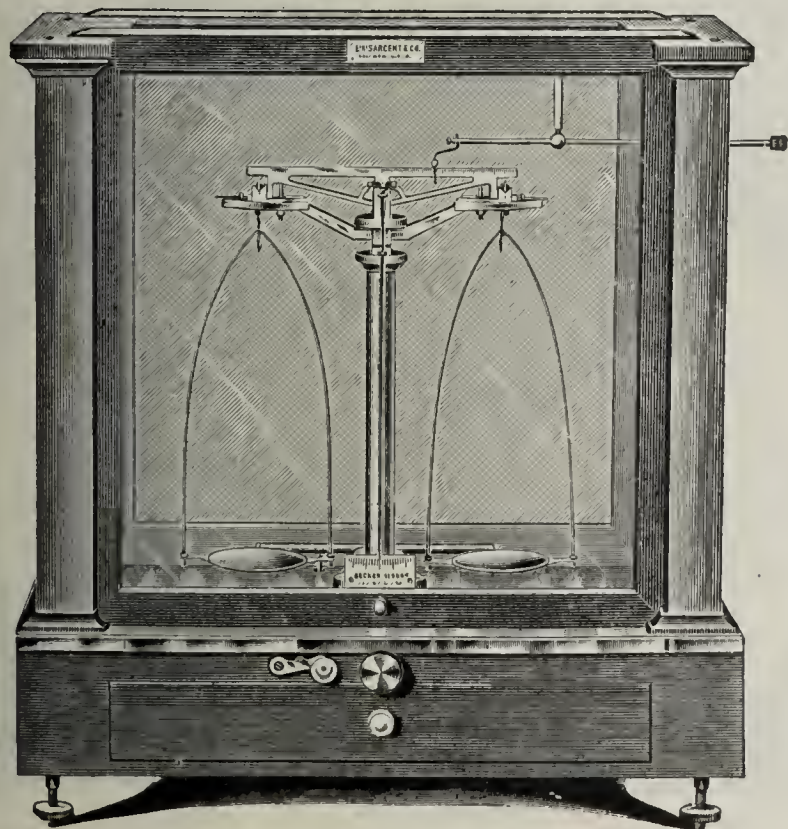
HAVE YOU AN IDEA?

If so write for our books: "Why Patents Pay," "What to Invent," "100 Mechanical Movements" and a Treatise on Perpetual Motion—50 illustrations. All mailed free.

F.G. DIETERICH & CO. Patent Lawyers and Experts

801 Ouray Block

WASHINGTON, D. C.



E. H. SARGENT & CO.

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN

CHEMISTS SUPPLIES

Of high grade only.

We call particular attention to our Cement Mould, Vicat Indenting Apparatus, as improved by us, Gilmore's Needles, Jackson's specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

CHICAGO



McCaslin Conveyor over Storage Bin Handling Hot Clinker

The McCaslin Conveyor

Acknowledged by Competent Engineers as the best Conveyor in the world for handling hot clinker, stone, etc., in **CEMENT PLANTS.**

Low Cost of Maintenance Absence of Shut Downs
Maximum of Efficiency

Manufactured solely by

Mead, Morrison Mfg. Co.

BOSTON

NEW YORK

CHICAGO

Catalog on Request

Send Us Your Specifications for an Estimate

Face Your Blocks

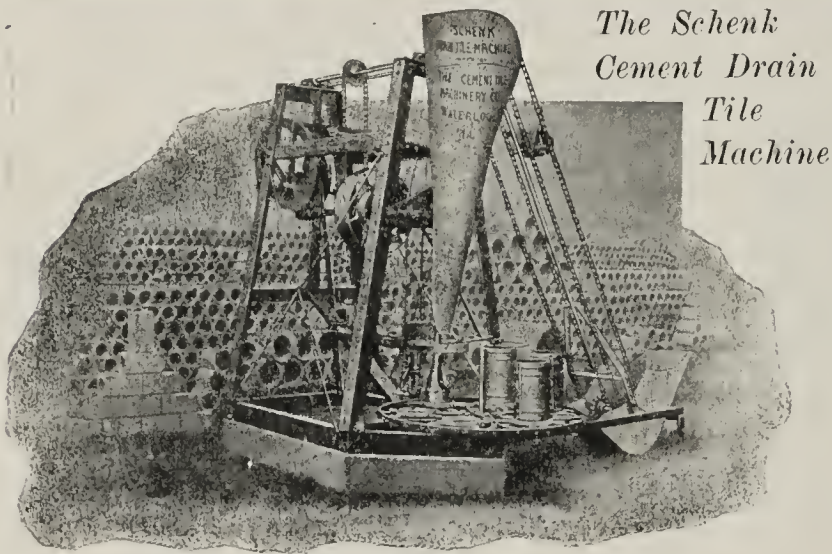
Make Them White

Do You
Use

WHITE SAND

Leading contractors specify our pure White, Washed and Screened Silica Sand for fine work in ornamental stone, block facing, porch work, ornamental lawn fixtures, vases, etc.
This sand is shipped both DRY and DAMP.
Prices and Samples on request.

BALLOU'S WHITE SAND COMPANY
MILLINGTON, ILLINOIS



*The Schenk
Cement Drain
Tile
Machine*

"Money in Cement Tile"

We have just published a little book with this title; it tells the whole story in a way you will understand.

Write for it today.

The Cement Tile Machinery Co.
Waterloo, Iowa.



Portable Elevators for Handling Stone and Gravel

**WELLER-
MADE.**

Illustration
Shows
Crushed Stone
Elevator.

Send for Catalog.

We manufacture these in all designs and for handling all classes of materials. Furnished with wood or iron frames, and of any desired capacity.

We furnish machines complete, ready for work, or the iron work alone.

Ask about our Belt Conveying and Power Transmitting Machinery.

Weller Mfg. Co.
Chicago.

The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa

WANT COLUMNS.

WANTED.

Chemist to take position of assistant chemist for two or three months, then chief chemist, for new plant in Montana. State experience, references, whether married or single, and salary expected. Address O. G., care Cement & Eng. News.

WANTED.

Position by chemist having 8 years' experience, 3 years as chief chemist. References furnished. Address A. A. B., care Cement & Eng. News.

WANTED.

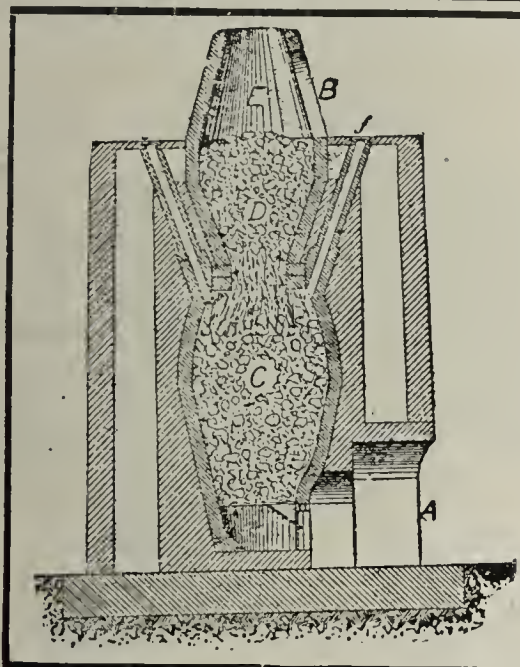
If you are interested in pumps of latest and best styles, send to us for book and catalogue. Pumps of all styles and for all used. The Columbus Steam Pump Works, West Broad street, Columbus, Ohio.

WANTED.

Position as Chief Chemist by young man with good technical education and 4 years' practical experience. Can furnish best of reference. Address E. B., care Cement & Eng. News.

WANTED.

Combined position as Superintendent and Chemist in Portland cement factory. Have had 5 years' experience as Superintendent and Chemist with large western mill but desire to make a change. Am familiar with both wet and dry process. College graduate with 5 years' additional experience as Chief Chemist with eastern mills. Address M. L., care Cement & Eng. News.



The Kiln & Chimney Construction Co.

197 HAVEMEYER STREET
BROOKLYN, N. Y.

We build Kilns for burning Lime and Cement, also

CHIMNEYS

REPAIRING and REMODELING
our SPECIALTY

MEACHAM & WRIGHT CO.

Sales Agents

IMPROVED

UTICA HYDRAULIC CEMENT

And Dealers in

LEHIGH PORTLAND CEMENT

Telephone Main 59 206 La Salle Street, Chicago

F. D. MEACHAM, Pres.
S. P. BLOUNT, Treas.

F. S. WRIGHT, Vice-Pres.
C. M. FOSTER, Secy.

POSITION WANTED.

Assistant Chemist (Lehigh University), desires position. Am also a first class accountant. Four years' experience. Address Chemist., 330 Fourth St., South Bethlehem, Pa.

Location for Cement Plant

Extensive Deposits of Raw Material. Proximity to Large and Growing Markets. Low-Priced Fuel Supply.



THERE ARE several desirable locations for Portland Cement Plants along the Santa Fe, where the advantages enumerated are to be found. If you are interested you can secure full and detailed information by addressing this office.

The SANTA FE is glad at all times to co-operate with those seeking locations or desirous of investigating conditions in territory tributary to its line. Correspondence from interested manufacturers is invited.

WESLEY MERRITT, Industrial Commissioner A., T. & S. F. Ry.
1122 Railway Exchange Building
CHICAGO, ILL

The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker 1½ inches diameter from the kiln and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

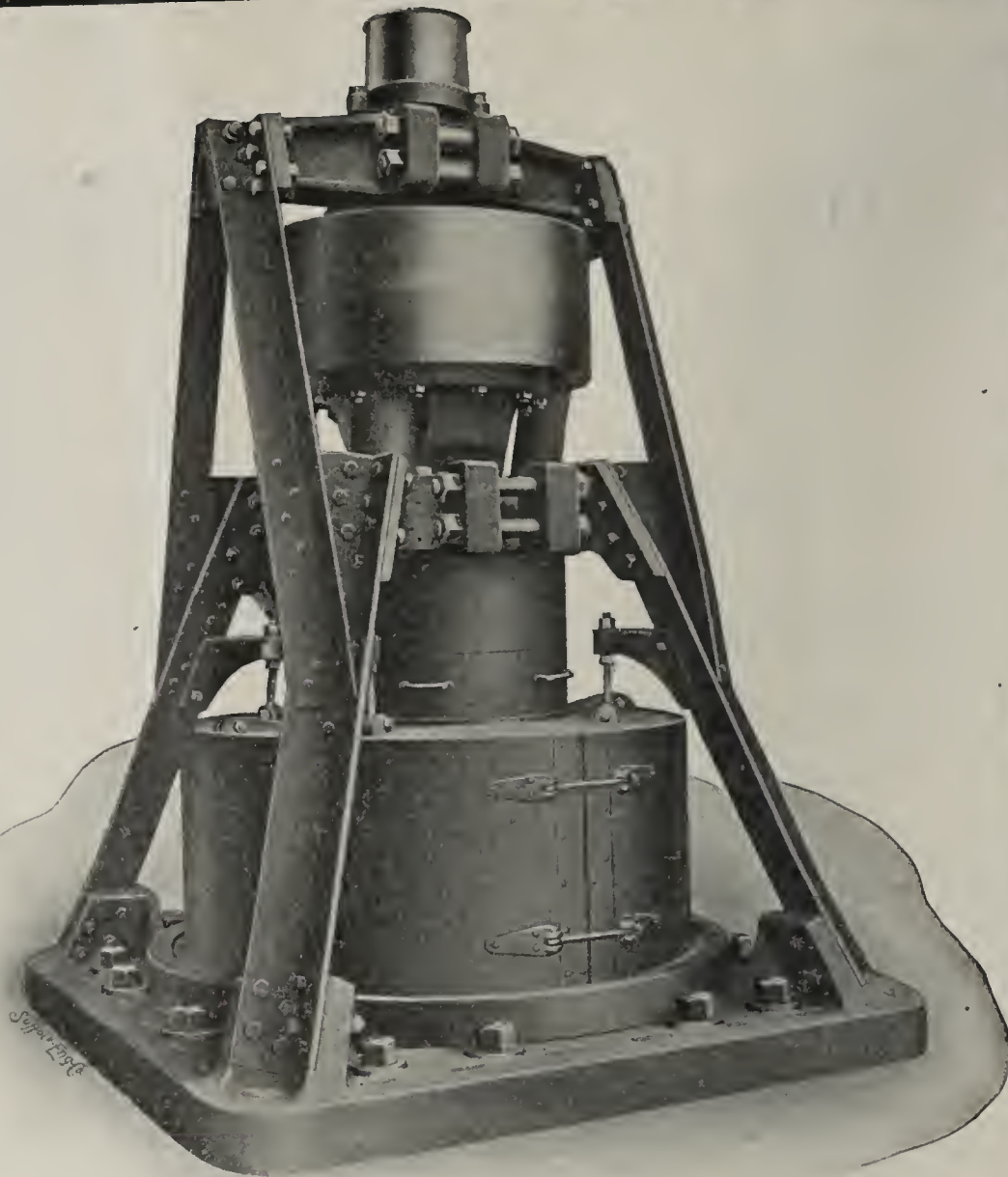
It saves cost in attention.

MANUFACTURED BY

BRADLEY PULVERIZER CO.

37 Walbrook
LONDON, E. C.

92 State Street
BOSTON



Hess Furnaces



No. 45

"Leader" Hess Steel Furnace

Price \$49.00

Delivered East of Omaha and North of Ohio River
Pipes and Registers Extra

for the past 7 years, have been sent to customers in every state in the Union, freight prepaid,

On Approval

and the money held back till sixty winter days of actual trial have proved that all our claims for superiority have been fulfilled.

Isn't this worth looking into? Could we offer such liberal terms if we didn't know that the Hess Furnace excels in service, simplicity, efficiency, economy?

All we ask of you, if you need a furnace, is to investigate—to put your name on a postal card, mail to us and ask us for our booklet "Modern Furnace Heating." This booklet is an authority on furnace heating, and copies have been requested by many colleges, libraries, etc., for reference in engineering and mechanical courses. It instructs fully in the principles and practice of furnace heating, and should be in the hands of every builder and house owner. It is free on request.

In Buying Direct

From Our Factory You Pay Only One Profit—A Small, Factory Profit.

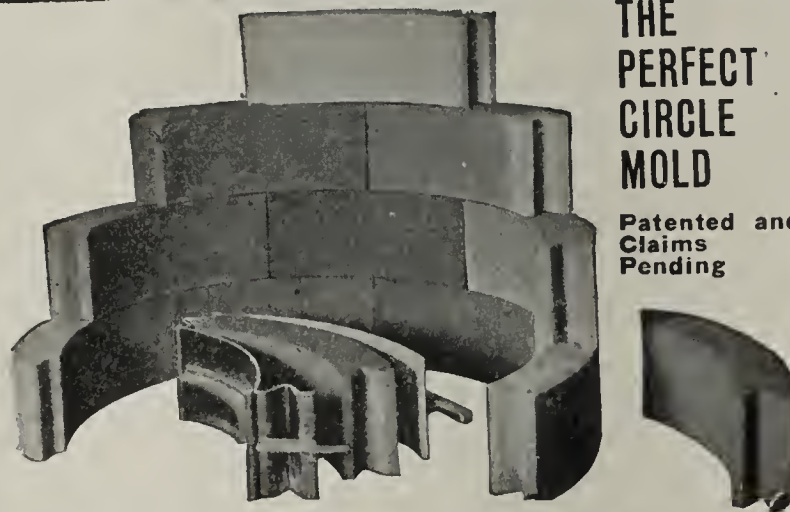
Our prices are not inflated with the usual cost for salesmen, branch stores, agents' and dealers' profits. The factory profit only, satisfies us, and you will be surprised at how much we can save you.

Special Heating Plan Free Before You Order

Let us have our experts prepare a special plan for heating your building. It will cost you nothing, and put you under no obligation to buy of us. Our thirty-six years of experience in designing heating equipments makes this free plan valuable to you.

Ask us more about it. A postal card today will serve the purpose.

Hess Warming & Ventilating Co.
919 Tacoma Bld., Chicago.



THE PERFECT CIRCLE MOLD

Patented and Claims Pending

The Perfect Mold was invented by C. S. Wert, of Kendallville, Ind. Manufactured in any sizes. In ordering give the Inside Diameter. The three most in use are No. 1, with diameter of its circumference 3 ft; No. 2, diameter of its circumference, 5 ft. No. 3, diameter of its circumference, 7 ft. Also 10, 12 and 14 ft. Diameters—used for silos.

CONSTRUCTION.

The circle mold is built of No. 10 gauge sheet steel, reinforced with T-Iron. The molds are 8-in. high, 4-in. thick, making them strong and durable. These curbing blocks can be made on the ground or floor, or can be made on wooden pallets. Those in the concrete manufacturing business cannot afford to do without one of these molds, as all up-to-date concrete plants are equipping themselves with one or more of my curbing molds, for they all see at a glance their importance and utility, simplicity in operation, durable construction, and lasting qualities in products, as well as completion of a well equipped plant, showing the ability of a man's occupation or business. These molds are no experiment but an up-to-date invention, practicable, durable, simple and useful, and are only appreciated by those who have them in store. Selling at a price within reach of all. The output of these molds is greater than can be produced on any other mold, thus reducing the labor and cost of making the products, and also increasing the Profits.

These molds will enable you to make better products than can be produced on any other machine or model and sell for more money. Just what an up-to-date concrete constructor needs is an up-to-date plant. In a class by themselves, possessing many advantages over all others. Absolutely the best and cheapest molds ever offered to the public. Write for prices.

C. S. WERT, 602 N. Main Street, Kendallville, Indiana.

THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

Design, Construction, Remodeling and Operation
of Portland Cement Plants

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street
New YorkCanadian Express Bldg.,
Montreal, Can.1121 The Rookery
Chicago425 Washington St.
San Francisco, Cal.Monongahela Bank Bldg.
PittsburghSyndicate Trust Bldg.,
St. Louis, Mo.Norfolk House, Cannon St.
E. C., London

The Osborn Engineering Co.

OSBORN BUILDING, CLEVELAND, O.

Civil, Mechanical and Electrical Engineers

Experts in the Designing of

CEMENT PLANTS.

Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement
Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of **Cement Machinery**

42 NORTH 16TH STREET

::

PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

COMMERCE BLDG.,
Kansas City, Mo.

Cement Engineers

Just Out!

Architects' and Engineers' Hand Book on
**Reinforced Concrete
Construction**

ONLY ONE DOLLAR
CEMENT & ENGINEERING NEWS

22 Fifth Avenue, - - - Chicago

MEDUSA WATER-PROOF COMPOUND

Makes all concrete watertight

Write for pamphlet describing its use. Do not accept a substitute, as there are many adulterated compounds on the market.
It is not a wash, or an experiment



Illustration of Soulard Public Bath House, St. Louis, Mo. Pool, Floors, Steps and Walls surfaced with Medusa Pure White Stainless Portland Cement, containing Medusa Water-proof Compound.



Sandusky Portland Cement Company

Sandusky, Ohio

Write for free Sample of our White Portland Cement

Obtain our prices on Medusa Portland Cement. Annual Capacity, 1,500,000 bbls.

IRON-ORE CEMENT

The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in place of Portland cement for all Marine Construction.

Send for Literature, Etc.

Worm-Cox Company
SOLE AGENTS

Marquette Building, Chicago

LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GROUND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.,
ALLENTOWN, PA.

Western Office:
725 ROCKEFELLER BUILDING,
CLEVELAND, OHIO.

ALPHA

PORTLAND CEMENT....

Alpha, N. J.
Works: Martins Creek, Pa.
Manheim, W. Va.
Alsens, N. Y.

Quality unexcelled The Recognized Standard American Brand Always Uniform

ALPHA PORTLAND CEMENT CO.

Manufacturers of but one grade—strictly straight Portland
General Office, EASTON, PA.

"MONEY CAN BE LOST"

"Through Mistaken Ideas of Economy"

It is not economy to buy a cheap article. Because we save you from 30 to 75% must not make you think you are getting a cheap or inferior article. No antediluvian out-of-date machinery can be found in our stock. Only the latest and most modern types are ever offered for sale, all of which are so thoroughly overhauled and rebuilt that they are practically as good as new when they leave our shops. SEND US AN INQUIRY.

ROCK CRUSHERS.

1—9 x 15 Allis Chalmers Jaw Crusher.

ROCK DRILLS.

6—Ingersoll-Sargeant Rock Drills, size 3 1/4 inches.
6—Ingersoll-Sargeant Rock Drills, size 3 1/8 inches.
Fitted for steam or air.

HOISTING ENGINES.

1—12x16 double cylinder, heavy duty LIDGERWOOD hoisting engine.
1—6x8 Marine Iron Works double cylinder, single drums, reversible in steam chest.

5,000 rolls rubber, leather and canvas belting, structural iron, shafting, pulleys, couplings, steel wire and manila rope. Smoke stacks, corrugated roofing and siding, hose hydrants, tanks, and supplies of all kinds. We can save you money on anything you require.

PUMPS.

3—24 inch Centrifugal pumps, 2 to 3,000,000 gallons capacity.
1—20x13x12 Wheeler & Tappen Duplex Pump.
1—20x13x12 Cameron Single Acting Pump.
1—12x7x12 Smithvalve Duplex Pump.
1—8x12x12 Smithvalve Duplex Pump.
7—6x4x6 Dean Steam Pumps, new.
6—4 1/2 x 2 3/4 x 4 Dean Duplex Pumps, new.
8—3x2x3 Duplex Steam Pumps, new.

LOCOMOTIVES AND CRANES.

4—9x16 inches Baldwin. 36 inch gauge.
1—5 ton Brown Locomotive Cranes, 25 foot Booms.

IRON PIPE.

70,000 ft. 1 inch Standard Pipe, 35,000 ft. 1 1/4 inch Casing.
50,000 ft. 1 1/2 inch Standard Pipe, 40,000 ft. 3 1/4 inch Casing.
30,000 ft. 2 inch Standard Pipe, 60,000 ft. 3 3/4 inch Casing.
2,000 ft. 10 inch Standard Pipe, 8,000 ft. 5 5/8 inch Casing.
4,000 ft. 12 inch Standard Pipe, 9,000 ft. 6 1/4 inch Casing.
30,000 ft. 8 inch Cast Iron Pipe, 1,000 ft. 6 5/8 inch Casing.
300 ft. 24 inch Cast Iron Pipe, 1,250 ft. 8 1/4 inch Casing.
1,500 ft. Riveted Steel Pipe, 24 inch to 72 inch diameter.

SEND FOR OUR NEW 500-PAGE CATALOG NO. 962..

A wonderful book of facts and information of the utmost value to purchasing agents in all lines of business. Send for one to-day. It will cost you nothing.

Chicago House Wrecking Co., 35th and Iron Streets, Chicago, Ill.

Colonial Trust & Savings Bank

A BANK FOR THE PEOPLE

Pays 3% on Savings Accounts

Capital and Surplus, \$1,106,620

YOUR ACCOUNT INVITED

205 La Salle Street, - - - - - Chicago, Ill



THE IMPROVED DIETRICH'S CLAMP

and

Form System for Hollow Walls

By the use of the Improved Dietrichs Clamp and Form System for Hollow Walls the

**COST OF CONCRETE
CONSTRUCTION IS
REDUCED 50%**

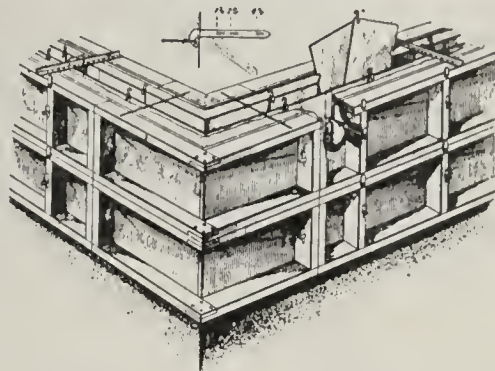
and the builder also secures a

**PERFECT
DAMP-PROOF WALL**

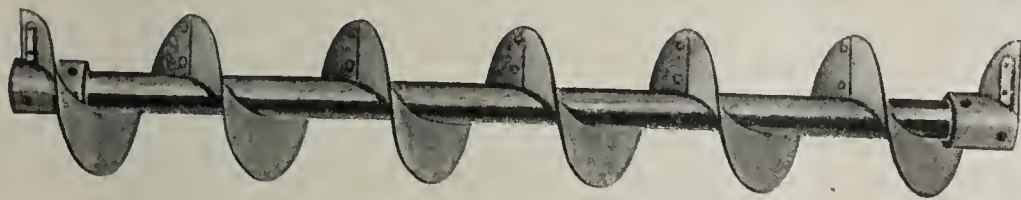
This system is based on the panel principle and employs removable sheet iron inner forms with sheet iron spacer. Corners, doors and window openings are provided for.

Write for pamphlet giving full information

DIETRICH'S CLAMP CO.
LITTLE FERRY, N. J.



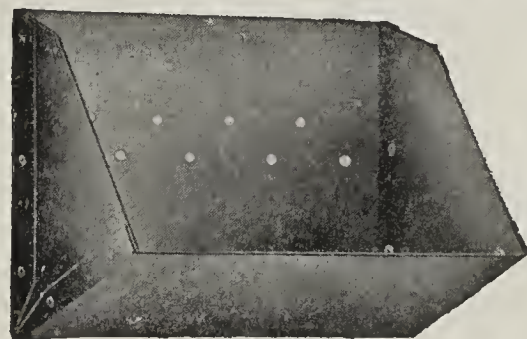
ELEVATING—CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys, Shafting, Shaft Bearings, Link Belting, Special Chains



HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES.
Catalog for the asking.

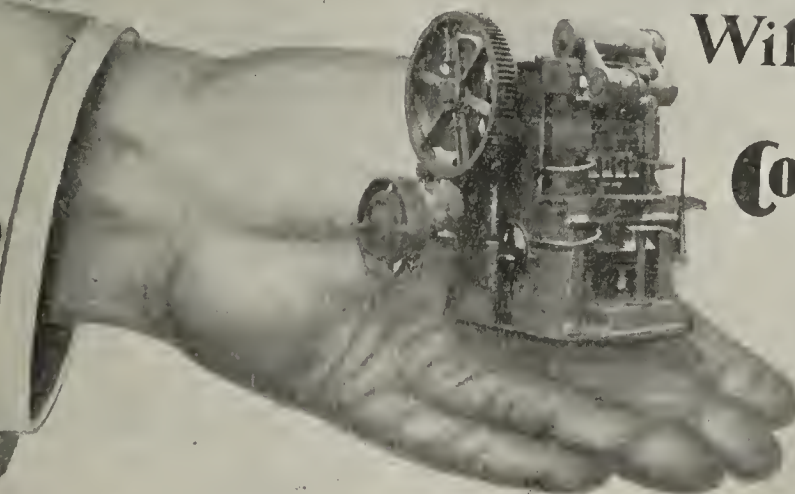
SKILLIN & RICHARDS MFG. CO., CHICAGO

ALWAYS
ON HAND

THE AMERICAN CLAY MACHINERY CO.
Willoughby, Ohio, U.S.A.

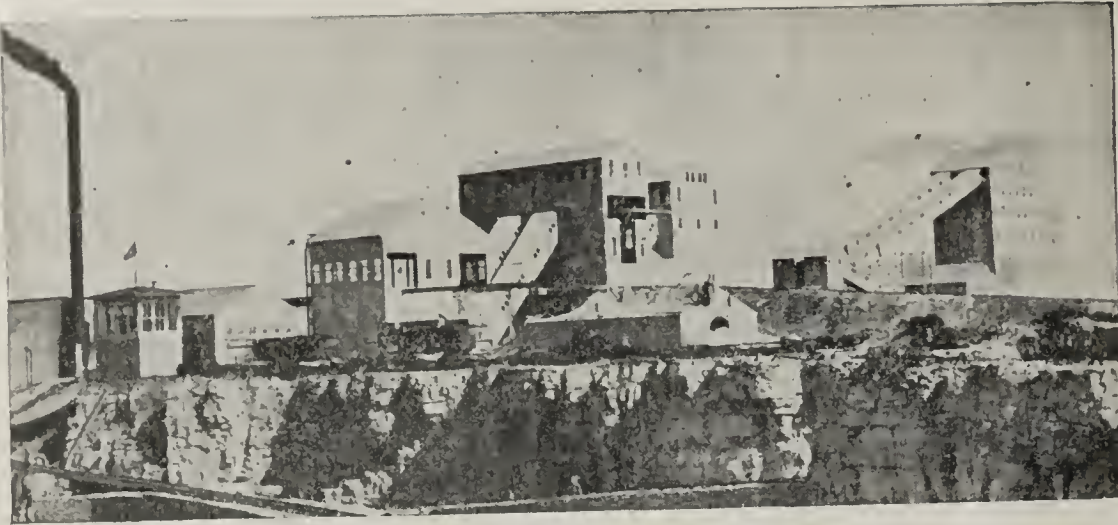


**PLANTS
DESIGNED**



**COMPLETE EQUIPMENT
FURNISHED,
AND INSTALLED
SET IN OPERATION**

SAND-LIME BRICK MACHINERY



Dolese & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world. Machinery throughout installed by us.

OLSON BROS. & CO.

Engineers and Contractors

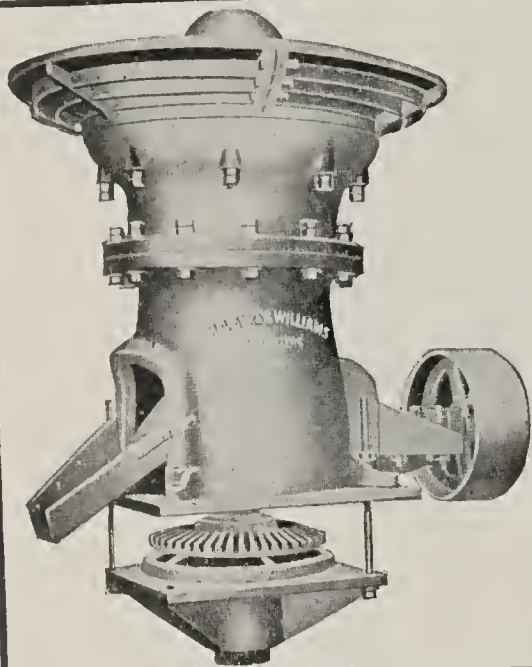
Cement Mill Machinery Erected, Stone Crushing
Plants Equipped and Erected. :: :: :: ::

ALSO COMPLETE PLANTS FOR HANDLING
COAL, SAND, GRAVEL, ORES, ASHES, ETC.

MODERN POWER TRANSMISSION
Elevating and Conveying Machinery.

Tanks and Vats, Especially in Connection with Machinery

2418-22 Bloomingdale Ave., Chicago



Kennedy Gyratory Crusher

The only Crusher built with a ball and socket eccentric which will lend itself to any change in the inclination of the main shaft. Improved hopper, more efficient dust collars.

— ALSO —

Cement Making Machinery

Kilns, Dryers, Tube Mills, Ball Mills, Elevators, Conveyors, Feeders,
Revolving Screens and Crushing Rolls.

Chalmers & Williams Inc.

1927 Commercial National Bank Building, - - - Chicago
120 Liberty Street, New York



TRADE MARK

PENINSULAR PORTLAND CEMENT

Acknowledged by competent Architects and Engineers
to be unequalled for fineness, wonderful development
of strength and sand carrying capacity.

"THE BEST IS THE CHEAPEST"

Address

Peninsular Portland Cement Co.
JACKSON, MICHIGAN.

Fire Brick Linings For Cement Kilns

STANDARD TESTING SAND AND
GENERAL BUILDING SUPPLIES

Garden City Sand Co.,
188 Madison St., Chicago

Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - - - 645 No. Sixth St., Terre Haute, Ind.

Channon's New Catalog No. 50

**of Contractors' Machinery
and General Supplies**

Ready for Distribution

Send for it

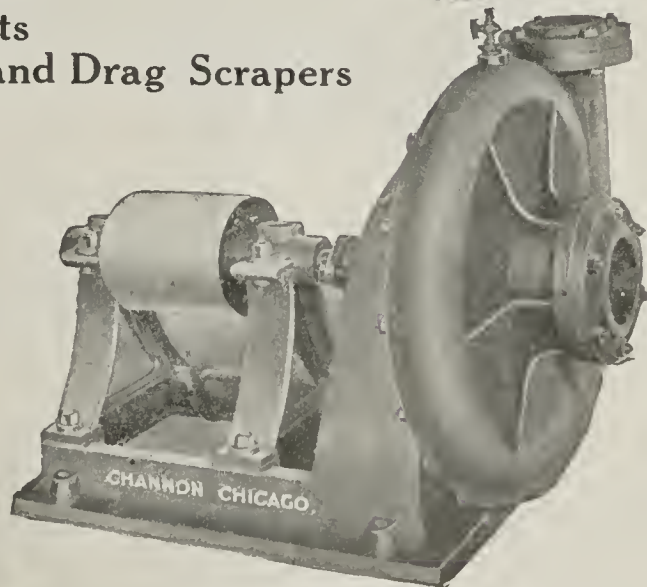


Mundy Hoisting Engines

This catalog describes machinery and general supplies of all kinds for contractors, bridge builders, cement plants, quarries, mines, mills, machine shops and other industries. This is a valuable book giving weights, prices, etc., and is sent without charge to those interested.

Here are a few of our Contractors' Specialties :

Channon Rotary Scraper Excavators
Hadsel Slack-Cable Scraper Excavators
Mundy Hoisting Engines
Channon Derrick Irons
 " Concrete Mixers
 " Material Elevators
Hayward Orange Peel and Clam Shell Buckets
Stuebner Concrete and other Hoisting Buckets
"K & J" Cars, Wheelbarrows, Carts, Wheel and Drag Scrapers
and Plows
American Saw Mills
Witte Gasoline Engines
Cameron Simplex Steam Pumps
Channon Centrifugal Pumps
Channon Diaphragm Trench Pumps
and a Complete Stock of
Hand Tools, Jacks, Shovels, Rope,
Blocks, Etc.



Channon Centrifugal Pumps

H.Channon Company.

Manufacturers

Chicago

Selling Agents

IT WILL PAY YOU TO USE CROWN HYDRATE

(HIGH CALCIUM HYDRATED LIME)

For Waterproofing and Concrete

It Improves Its Strength and Color. Ask the

Marblehead Lime Company

KANSAS CITY

CHICAGO

German-American Port-
land Cement Works

OWL CEMENT

Illustrated Pamphlet Mailed on Request

E. L. COX, General Sales Agent,
1527 Marquette Bldg.,

Works: La Salle, Ill. CHICAGO

DEALERS ATTENTION!

Why not secure
the agency for
"Stonkote" Ex-
terior Wall Plaster.

No lime used.
Absolutely water-
proof.



"White Swan" Wall Plaster For Interiors

"R. I. W." Paint For Damp Proofing

Why not get our book. A postal card will bring it to you.

The Garden City Sand Co.

208 Chamber of Commerce

Chicago

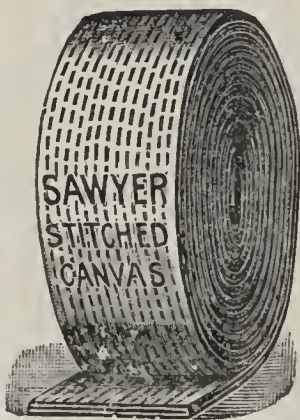
Peerless Portland Cement

MANUFACTURED AT UNION
CITY, MICH.

**Every Barrel
Guaranteed**

Fineness, Uniformity of Color
and Sand Carrying Qualities
equal to any Portland Ce-
ment Manufactured

Improved Canvas Stitched Belting



We Specialize in making Belts
for use in Cement Plants.

Light or Heavy Transmission,
Elevator or Conveyor Belts for
Wet, Dry, Hot or Rough condi-
tions.

Sawyer Belting Co.

Cleveland, O.

Send for Book "K."

Why Don't You?

Make Your Own Cement in the manufacture of SILICATE BRICK and STONE out of Sand, Slag, Quarry-Waste, or any silicious material, with a small percentage of Lime.

Our "DIVISION-METHOD" will produce a higher grade product at a lower cost than can be made under any other process.

"RAW MATERIAL TO FINISHED PRODUCT—24 HOURS."

We furnish all Machinery, erect complete Factory and turn it over in perfect running order.

Write for full particulars to

International Sand-Lime Brick & Machinery Co.

90 WEST STREET, NEW YORK CITY

ENGINEERS AND CONTRACTORS FOR SILICATE BRICK AND STONE FACTORIES.

The Right Power For Concrete Workers

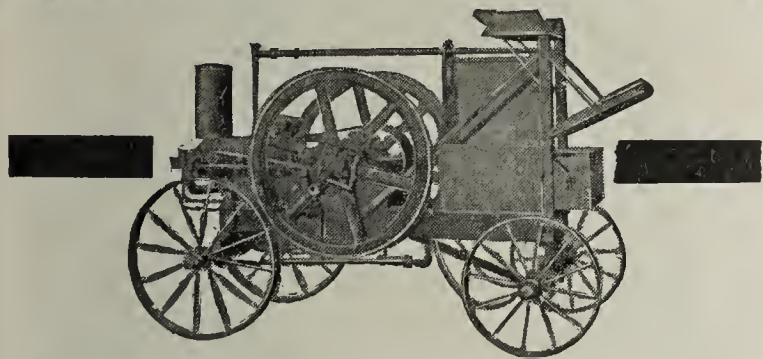
YOUR engine is in the I H C line. For you want greatest efficiency, combined with economy, simplicity, strength and durability. Your engine must work hard, in all kinds of weather, under the most trying conditions. That is why

I H C Gasoline Engines

have been the choice of concrete workers who want the right power. See the local International agent about the I H C engine to meet your requirements. Any horsepower, vertical or horizontal, stationary or portable, air or water cooled, mounted on skids or trucks. Catalogue and full information from agent or direct from us.

International Harvester Company of America

INCORPORATED
41 Harvester Building. CHICAGO, U. S. A.







OFFICES

- BIRMINGHAM
- BOSTON
- BUFFALO
- CHICAGO
- CINCINNATI
- DENVER
- DULUTH
- HAZLETON
- HOUGHTON
- HUNTINGTON
- JOPLIN
- KANSAS CITY
- MEMPHIS
- MEXICO CITY
- NASHVILLE
- NEW ORLEANS
- NEW YORK
- PHILADELPHIA
- PITTSBURG, PA.
- PITTSBURGH, PA.
- PORTLAND
- SALT LAKE CITY
- SAN FRANCISCO
- SCRANTON
- SEATTLE
- SHREVEPORT
- SPOKANE
- SPRINGFIELD
- ST. LOUIS
- TERRE HAUTE

DU PONT BLASTING

GELATIN is recommended for QUARRYING very hard rock. It can be used in the same bore hole with other Du Pont High Explosives.







E. I. DU PONT DE NEMOURS POWDER CO., Wilmington, Del. U. S. A.

COPYRIGHTED BY E. I. DU PONT DE NEMOURS POWDER COMPANY, 1910

CHARLES F. MCKENNA, Ph. D.

Inspection of Cement

and all other Engineering Materials. Examination of Properties and of Economical Operation of Works.

**Consulting and General Practice in
Chemistry, Technology, Chemical
Engineering and Chemico-
Legal Cases.**

Long Distance Telephone. Cable Address: PLAT PEARL
Laboratories: 221 Pearl St., New York City
Offices: 50 Church Street

Hotel Cumberland

NEW YORK

S.W. Cor. Broadway and 54th St.

Near 50th Street Subway Station and 53d Street Elevated

**HEADQUARTERS FOR THE CEMENT
AND MACHINERY MEN.**

New Modern Fire Proof

All Outside Rooms. No Carpets. All Oriental Rugs.

Transient Rates \$2.50 with Bath and up.

10 minutes walk to 20 theatres.

Send for Booklet.

HARRY P. SIMPSON, Formerly with Hotel Imperial.

R. J. BINGHAM, Formerly with Hotel Woodward

WATCH

your maintenance costs and ascertain just what ordinary steels cost you per barrel of finished product, then install

Tisco Manganese Steel

and you will be surprised at the way repair costs decrease and the efficiency of your machines increases. Ask us to submit figures on some interesting tests that prove our claims. : : : : : : : : :

THE FINAL TEST OF SUPERIORITY IS IN COMPARISON!

We Guarantee Economy!

TAYLOR IRON & STEEL CO.

HIGH BRIDGE

::

NEW JERSEY

THIS POWERFUL AUTOMATIC BLOCK MACHINE

Makes 1000 Blocks 24"x12"x9" in 10 Hours.

Each block receives **20 TONS** "SQUEEZE" twice from opposite directions.

Ours is the only 1 piece, double air space, building block on the market.

WESTERN SHAW BLOCK CO.

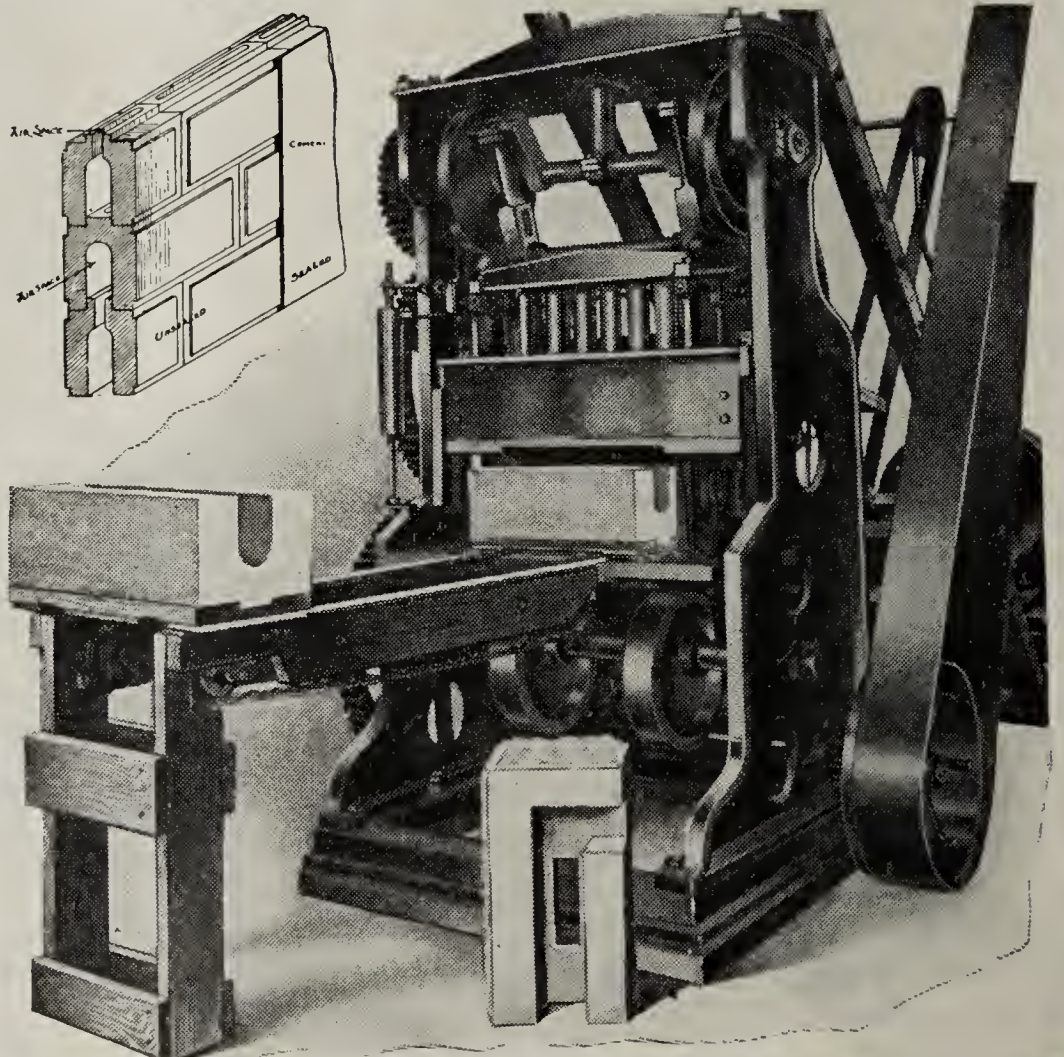
Room 317

218 LA SALLE ST., :: CHICAGO, ILL.

Our terms permit you to pay for the machine with a small per cent of your profits.

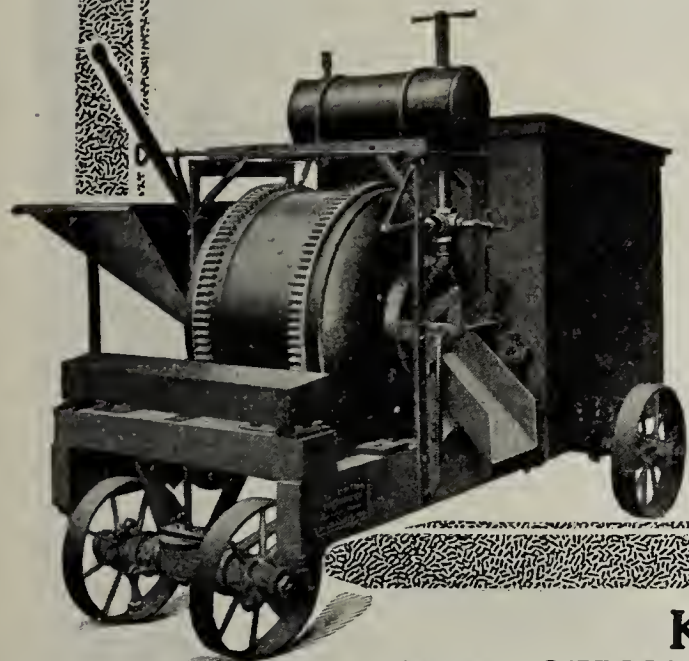
With this plant you can successfully compete with common brick, and be independent of the competition of any other building block machine.

Consult your own interest and get in on this live proposition.



By Any Standard of Quality The Koehring Concrete Mixer Is Peer

In Quality of Product
—Quantity of Output—
Manual Labor Saved
and Dependableness
of The Machine—
None Other Excels.



THREE independent mixings in the one drum, each performed by a positive mechanical force, with no sharp angles or corners is a guaranty of quality of mixing.

Lifting and pouring from the side, casting alternately from end-to-end, breaking over against heavy cast iron heads of the drum and a constant pouring off the inner end of the discharge chute represents a rapidity of mixing no other equals.

Discharging by merely raising the inner end of the discharge chute and always taking out the exact quantity desired, is manual labor economy you know is the minimum.

The heaviest constructed drum on any mixer, resting on trunnion rollers placed close to the ends, the rollers cast with wide faces, chilled as hard as tempered steel, and a double gear drive with pinions placed high to prevent binding in case the drum settles, comprises a dependableness the greatest mechanical genius will never question.

Built in types and sizes for every requirement; equipped with gasoline, steam or electric power.

It's chock full of dollar-saving quality—quality in the concrete and quality in the machine. Ask for "Catalog B."



KOEHRING MACHINE COMPANY

614-616 GERMANIA BUILDING

MILWAUKEE, WIS., U. S. A.



ATLAS

CEMENT LIBRARY

Concrete Construction about the Home and on the Farm	Free
Concrete Houses and Cottages. Vol. I. Large Houses.	\$1.00
Vol. II. Small Houses.	1.00
Concrete in Highway Construction	1.00
Reinforced Concrete in Factory Construction (delivery charge).	.10
Concrete in Railroad Construction	1.00
Concrete Cottages	Free
Concrete Country Residences (out of print)	\$1.00
Concrete Garages	Free

The books in this library contain the most complete and exhaustive information ever published by a manufacturing company in the interest of any industry. They have been compiled at an enormous expense by the most expert engineers in the country who have striven to present the subjects in a clear, concise and unbiased manner.

Send for any or all of them to

THE ATLAS PORTLAND CEMENT CO.

Dept. 3 30 Broad Street New York

Productive capacity over 50,000 barrels per day—
The largest in the world.

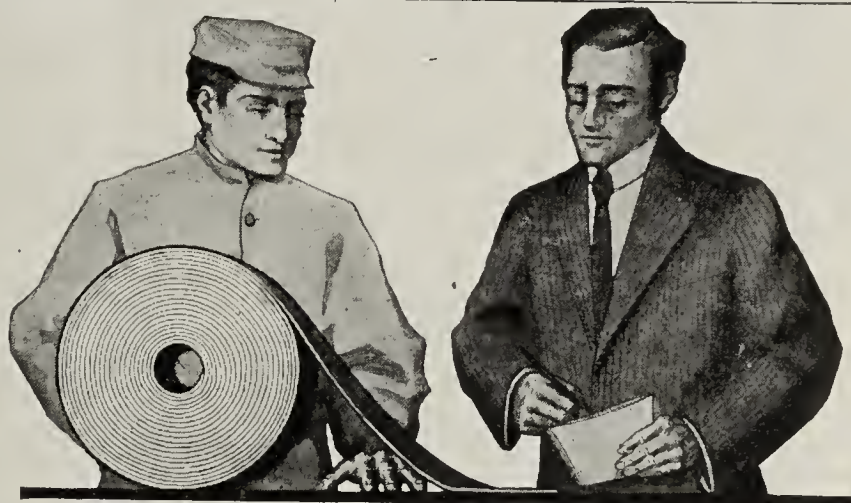


FIGURE THE COST

If one Reliance belt lasts twice as long as two ordinary belts and costs only a trifle more to *buy*, besides giving greater efficiency, needing few if any repairs and causing no trouble, which is the most economical belt to use?

RELIANCE

**Guaranteed
Leather Belting**

is the highest quality made. We recommend it especially

For Cement Plants

where it does the severest work without stretching or quickly wearing out. Our broad experience will prove of value to any manufacturer seeking utmost durability and efficiency. Where a waterproof belt is necessary Sea Lion will prove highly satisfactory—we guarantee it.

Write for Booklet.

Chicago Belting Company

12-22 Green St., Chicago

Branches: New Orleans, 431 Gravier St. New York, 71 Dey St.
Portland, Ore., 94 First St. Philadelphia, 234 North Third St.



"Safest to use, because richest in Bitumen"

"Pioneer"

OUR asphaltic products were first introduced in 1896. For 14 years they have been undergoing the hard practical tests of every day use, and Engineers of repute in all parts of the United States are specifying "Pioneer" Asphalt materials today, because these materials have proven superior to all others.

Wherever there is a reservoir to be waterproofed specifications should be adopted which will prohibit the use of an inferior grade of asphalt. Wherever pipe line construction is in progress the question of *protection and preservation* of the pipe ought not to be decided upon mere claims, but the rigid demands of *specifications that are safe* should be enforced as a check upon lax methods and inferior materials.

"Pioneer" Reservoir Waterproofing Asphalt "Pioneer" Mineral Rubber Pipe Coating

Here are two commodities that will meet the demands of the specifications suggested. They are not experimental, but have both been used with the highest success for years, and under the severest conditions.

Over 99½% Pure

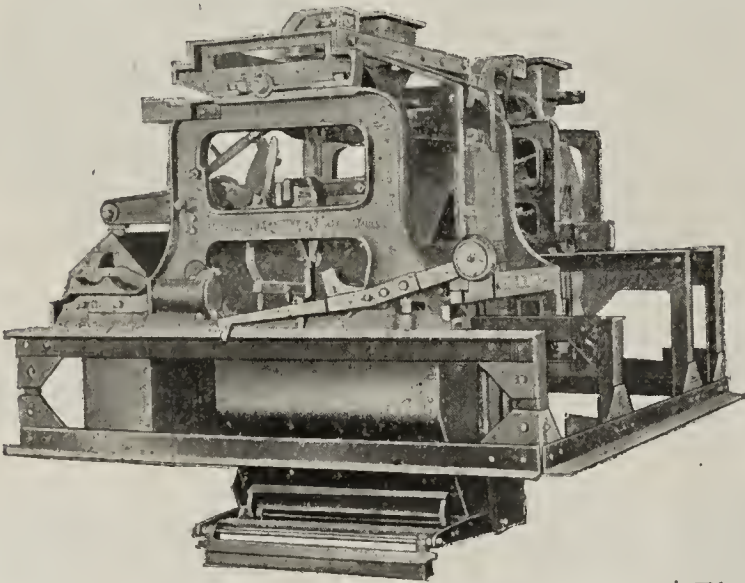
The superior quality of our asphalt is a *proved-out* proposition—a *known quantity*. Our own mines in Utah contain immense deposits of the purest hydro carbon known, our Gilsonite analyzing over 99½ per cent pure bitumen. In any true technical comparison of values "Pioneer" Mineral Rubber Pipe Coating and "Pioneer" Reservoir

Waterproofing Asphalt will readily demonstrate the superiority which has made them practically non-competitive. **Specifications** Send for our specifications and be safeguarded against those asphalts (which are offered as being equal to "Pioneer") the employment of which has, in spite of claims, proven them to be inefficient.

The American Asphaltum & Rubber Co.
600-614 Harvester Bldg.,
Chicago, Ill.

A
14
Year
Record
of Success

TO MAKE THE BEST CEMENT, USE Richardson's Automatic Proportioning Scales



Two or more scales yoked together with our Electric Discharge Mechanism will weigh Crushed Raw Materials direct from bins with perfect accuracy and discharge simultaneously.

These machines fitted with our Conveyor Feed will also weigh Pulverized Materials direct from bins.

Greatest Possible Range of Weights. Exact Proportions Absolutely Guaranteed. Continuous Uninterrupted Operation.

Similar Machines for Clinker and Gypsum. Automatic Hopper Scales for weighing Cement to Stock Bins. Automatic Bagging Scales for Finished Cement. Speedy and most accurate yet devised.

Write for particulars to

RICHARDSON SCALE COMPANY.
16 Park Row, NEW YORK 122 Monroe St., CHICAGO

Cement Sewer Pipe Is the Large Profit End Of the Concrete Business



Miracle Cement Pipe Molds have been in general use throughout America and many foreign countries for the past five years, and are giving universal satisfaction. Within the past three months large plants have been equipped for the manufacture of cement pipe by the use of Miracle molds in the cities of Denver, Tacoma and Seattle, which cities have opened their specifications to the use of cement sewer pipe.

Special Sewer Pipe Catalog (Just Out.)
New Mixer Book (Just Out) Get one.
Sent FREE to readers of this Magazine.

MIRACLE PRESSED STONE CO.

Department "L."
MINNEAPOLIS, MINN.

CEMENT

... AND ...

ENGINEERING NEWS

CEMENT PIPE RAPIDLY REPLACING SALT GLAZED, VITRIFIED AND ORDINARY BURNED CLAY PIPE FOR SEWER, DRAINAGE AND OTHER PURPOSES



GREAT PROFITS IN THE MANUFACTURE OF CEMENT SEWER PIPE

The above illustration is a view of the cement sewer pipe yard of A. L. De Shazo of Memphis, Tenn., who started to manufacture cement pipe about three years ago and has been very successful, and has found the business very profitable. He started in a very modest way, and during the year 1909 the total amount of his sales aggregated \$15,000. His net profits for the year 1909 were over 25 per cent. of the gross amount of business transacted. Mr. De Shazo uses the Miracle molds, exclusively, for making bell-end and straight cement pipe, manufactured by the Miracle Pressed Stone Company of Minneapolis.

Cement pipe has been in general use in some cities of this country for over twenty years and especially in Milwaukee and Brooklyn where it has given the very best of satisfaction. Within the past few months a number of other larger American cities have included in their specifications the use of cement pipe. The city of Denver recently awarded its first large contract for cement sewer pipe. The amount of the contract is about \$66,000. Bids were solicited on both cement and clay pipe. Numerous smaller cities are adopting cement pipe.

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue

Cable Address -- "Seaferts" Chicago.

Entered at the Post Office at Chicago, as Second-class matter, July 21, 1896
under Act of March 3d, 1879.

Subscription. \$2.00 Per Year
Foreign Subscription. \$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON

Advertising Manager

CHICAGO, MAY, 1910.

REASONS FOR DEVELOPING OUR LARGE RESOURCES OF NATURAL PUZZUOLANA.

During every stage of the development of the American cement industry, an important problem had to be solved by the cement manufacturer and consumer, that was especially characteristic for the period in which it confronted the American cement world. Thus we have witnessed the early endeavors of the manufacturer to produce cement in competition with foreign countries, which necessitated a complete revolution of the old-time manufacturing process. The next step was to turn out Portland cement of as high a quality as the imported article. Also this was accomplished in the course of time. The rich harvest reaped by the first producers in the field induced capitalists all over the country to erect cement plants. As a result of it, the industry grew immensely and the profits declined. This led to the third period during which the manufacturer had to learn to practice the utmost economy. Upon this followed the rivalry of the many cement companies in existence, who began to feel crowded, and their efforts in regulating the sales and in keeping up the reputation of their brands by imposing rules for the delivery of cement upon their members. Scientific research on the part of the cement manufacturer as well as consumer grew out of the aim to standardize the methods of production and application. A number of associations composed of members of the various parties, namely manufacturers, consumers and engineers, acting as the latter's advisers, successfully led an active campaign of education for a number of years, so that it appears to-day, as if nothing new can possibly be added to the numerous chapters of research under investigation and as if a period of quiet labor is to follow, during which the methods adopted so far will be submitted, as the most reliable proof, to the test of time.

However, while apparently every one, interested in contributing his share towards the solution of the problems at issue, is quietly engaged in serious investigations of one kind or another, some far-sighted and restless minds broach new subjects of importance now and then and encourage us to march onward and to fix our eyes upon even higher and loftier points the minute we believe to have reached the summit and feel to be entitled to a rest. Thus, there is no standstill in the development of engineering problems; one question leads on to another; and all will be solved in time thanks to the indefatigable human mind.

A glance at the programmes of the various engineering societies shows that from year to year new subjects of discussion are added to the former, subjects about which little was known up to the time or which had not been even thought of, until failure of a certain method or material revealed deficiencies of some kind and forced the subject to the front.

Most of us, who are interested in the manufacture of cement, have probably never given it a thought that Portland cement, of which 60 million barrels are being manufactured in this country annually, can ever be improved or that its cost of production can be cheapened any further. We would naturally think that a product, of which such vast quantities are manufactured, represents the highest limit of perfection, and yet, during the past ten years more than ever before, the opinion has grown that it can be considerably improved in quality and at the same time be lowered in cost. In substantiating this remark, we refer the reader to Mr. Feret's article on "Puzzuolana Admixtures", of which a translation appeared in the January issue of the Cement & Engineering News.

From this publication will be seen that European countries have made extensive use of admixtures of natural and artificial puzzuolanas in the past. The statistics prove that, ever since the beginning of the discussions of the subject, the consumers did not wait for their Governments to sanction the practice and to declare Portland cements containing admixtures of puzzuolanas equal to pure Portland cement, but that the consumption increased ten-fold in spite of the greatest efforts made by the opponent party to discourage the use of puzzuolana admixture. The benefit of the admixture of these volcanic products became especially apparent in sea-water construction. All reports of the various Governments, and of late even the report of the Association of Scandinavian Cement Manufacturers on tests conducted for a period of ten years, show that mortars, as customary for construction on land, are entirely too lean for marine construction; that all mortars consisting of 1 part of Portland cement to 3 parts of sand infallibly went to pieces in sea-water. As the only way out of this dilemma, the Scandinavian cement manufacturer suggested to make use of richer mortars. Fortunately, however, for the party who has to pay the bills, all tests made with puzzuolana admixtures proved to be perfectly satisfactory also in lean mortars, so that it has become the aim of the large consumer to mix puzzuolanas with Portland cement or preferably to buy a cement to which the admixture has been made at the factory.

In Europe, a number of large deposits of natural puzzuolana have been known since ancient times. The Romans made use of them in combination with hydrated lime in all of their large constructions. "Santorin earth", "puzzuolana" (from Puzzuoli or Puteoli, a town at the foot of Mount Vesuvius) and the "trass" of the Eiffel were known for thousands of years and represented the most famous deposits of volcanic lavas in Greece, Italy and Germany. European countries, therefore, knew their value and did not lack an abundance of suitable deposits.

A different task, however, confronts the American consumer of cement, who is now gradually awakening to the importance of the situation and who will not be slow in profiting from the experience made by Europe, to judge from the progress he has made in the application of cement material heretofore. The West and Middle West are especially fruitful fields for the manufacture on a large scale of "Puzzuolana-Portland cement", cement consisting of a mixture of about two-

thirds of Portland cement and one-third of puzzuolana, or even of equal parts of each constituent; in the latter case the mixture of Portland cement and puzzuolana has to be ground to greater fineness.

As said before, there is a two-fold reason for making this admixture. In the first place, it improves the resistance of the cement to chemical influences without decreasing its strength, but on the contrary it increases it in the long run, and in the second place, it lowers materially the cost of cement in all localities, where Portland cement is expensive and where the volcanic rock is not too far distant. These conditions exist particularly in the West and, for this reason, cement manufacturers and large contractors have tried for some time to locate deposits of natural puzzuolanas in the Western states. Their efforts have been crowned by success in the states of Nebraska and Oregon, where extensive formations of volcanic lavas of suitable composition have been discovered; and there is no doubt, that many more of the immense layers of tufa to be found in the Rocky Mountains and along the Pacific Slope will prove to be equally fit for the purpose. Possibly many additional deposits are known to parties who made a quiet survey of the various locations and are only waiting for the day, when also the American cement user will be sufficiently educated on the subject and be convinced of the merits of puzzuolana admixture.

In studying these volcanic products, the question how to determine their value as cement material has become of paramount importance since the investigation of puzzuolanas forms a part of the programme of the International Society For Testing Materials. In this country little or nothing has been contributed so far to the general knowledge of the subject, because the few persons, who have examined deposits of natural puzzuolana, have conducted their tests most likely in an arbitrary way without conforming to rules customary abroad. Nevertheless, it would be of interest to the profession to learn something about the methods employed, no matter how crude they were, and to obtain some idea of the composition of the materials and of the results obtained. Cement & Engineering News will be glad to transmit through its columns to the consumer of cement and to the engineering world at large all information it may receive on this subject that occupies to-day one of the most prominent positions among the many subjects under investigation.

To our knowledge Dr. W. Michaelis Jr. of Chicago is the only person in this country who has made a thorough study of this subject and who succeeded in locating on the Pacific Coast puzzuolanas which resulted in cements of the same strength as the highest grade of Portland cement, even in mortars as lean as 1 cement to 5 sand, if mixed in the proportions of 3 Portland cement to 1 puzzuolana as well as in the ratio of 1 Portland cement to 1 puzzuolana. As soon as these tests will be finished, which extend over a number of years, we shall present to our readers a very interesting communication on the subject.

We may add that all testing of volcanic products in combination with cements is of little avail, unless at the same time comparative tests are made with the pure cement, that is to say Portland cement without admixture of puzzuolana and, furthermore, with the same grade of Portland cement to which, instead of ground puzzuolana, an admixture of powdered quartz sand of the same fineness is made in the same proportions as the puzzuolana-Portland cement mixture. Only this will show the real value of the application of puzzuolana, as small admixtures of finely

powdered quartz sand often increase the strength of a cement by filling of the voids of the mortar. However, if 30% or even 50% of the mixture consist of powdered quartz, the strength of the mortar is, at all periods of testing, very much lower than that of the pure Portland cement mortar, whereas in the case of an admixture of 30% or 50% of a true puzzuolana the strength of the puzzuolana-Portland cement mortar equals that of the pure Portland cement mortar after several weeks or months and surpasses, as a rule, the strength of the latter in the course of time.

NEW POSTAL REGULATIONS.

Subscriptions to Magazines, Etc., Must be Paid in Advance or They Cannot be Mailed for Less than Four Cents per Pound.

Uncle Sam has declared through the Postmaster General that hereafter magazines, etc., can only be mailed at the one cent per pound rate to bona fide subscribers who have paid for same in advance. To all others, including subscribers to Cement and Engineering News who are delinquent more than four months, the postage rate after April 1st, will be increased to four cents per pound. With Cement and Engineering News, this means two to three cents extra per copy, or an additional cost of thirty cents per year.

In consequence of this ruling by the postmaster general, we are obliged to ask our subscribers who have not already done so to at once remit the amount due us on subscription account. Naturally we regret this virtual prohibition by the government of the extension of credit to subscribers. We ourselves would gladly continue the same method of carrying our subscribers and awaiting their convenience as in years gone by, but this new postal regulation forbids that, without an extra charge of 30 cents per annum to cover the extra postage required.

The demands of the Postal Department are inexorable, and must be observed.

HERE IS THE RULING:

Postal Laws and Regulations—Second Class Matter, Sec. 436.

"Expired Subscriptions: 3. A reasonable time will be allowed publishers to secure renewals of subscriptions, but unless subscriptions are expressly renewed after the term for which they are paid, within the following periods: * * * Monthlies, within four months; they shall not be counted in the legitimate list of subscribers, and copies mailed on account thereof shall not be accepted for mailing at the second class postage rate of one cent a pound, but may be mailed at the transient second-class postage rate of one cent for each four ounces or fraction thereof, prepaid by stamps affixed."

Our readers will observe that we have no choice but must comply with the above ruling; consequently we earnestly request subscribers to Cement and Engineering News to aid us in the matter by remitting promptly in advance, as the Government requires.

FUSED PORTLAND CEMENT.

By C. Unger.

Translated by Dr. W. Michaelis, Jr.

In the following paper C. Unger gives, in the first place, a comprehensive review of the numerous attempts that have been made to explain the constitution of Portland cement. He compares the various methods employed by the experimenters and points out their advantages and shortcomings. The result of this retrospect is that, in spite of many careful and elaborate researches made heretofore, the true composition of Portland cement clinker is still as obscure as ever.

The main difficulty that, in the opinion of the author, his predecessors encountered lay in the fact that Portland cement, a product burnt only to the point of vitrification, contained its component parts in the form of not sufficiently developed microscopically small grains or crystals. He, therefore, conceived the idea to increase these constituents, true chemical compounds or mixtures of them or whatever they may prove to be, to the size of macroscopic bodies that could be examined under the microscope as well as be subjected to chemical analysis. This he hoped to achieve by raising the burning temperature to the point of fusion. His second chapter is, consequently, devoted to a detailed description of experiments carried on in this direction, which, although deviating from the plane of actual cement burning with regard to the temperature employed, offer many novel features and permit of a chemical determination of crystals of fair dimensions that can be separated from the surrounding fused mass.

The growing of such crystals is made possible by Unger through the erection of a large electric furnace in which several hundred pounds of Portland cement raw mixture are fused within a short time and allowed to cool slowly. This application of mechanical devices closely corresponding with operation in actual practice, as far as size and quantity is concerned, makes his experiments especially interesting to the cement manufacturer. No one before him has ever made similar experiments on so large a scale and this explains why he is able to offer much additional information, which other investigators working with small laboratory furnaces could not possibly give.

By this valuable contribution to the cement literature Unger has corroborated the statement of a number of former investigators, namely that Portland cement does not represent a true chemical compound, but a mixture of several more or less well-defined chemical compounds. He, furthermore, has proven that all experimenters who assumed a "tri-calcium silicate" to exist in Portland cement were mistaken.

The reading of the descriptions of his experiments is both interesting and instructive, and will afford a pleasant pastime to any one acquainted with the publications on the constitution of Portland cement by Le Chatelier, Newberry and Richardson:

INTRODUCTION:

During the past years it has often been declared impossible to determine the constitution of Portland Cement by purely chemical methods. This pessimistic opinion is due to the fact, that, in spite of the most laborious efforts made, for generations, both by analysis and synthesis, no one has succeeded in determining, in a manner beyond criticism, the part which the

various elements of Portland cement take in its formation and hardening and that, to-day as much as ever before, the opinions of the numerous investigators are diametrically opposed.

The physico-chemical methods, which likewise have been employed several times, have also failed to throw sufficient light upon the real nature of Portland cement, because the difficulties to be encountered are the same in this case; it is impossible to distinguish the various reactions going on at the same time.

In opposition hereto, the investigation has been taken up again by two parties who try to reach the goal by a thorough research of the fundamental reactions. Although they follow different roads, both of them aim to achieve their object by purely chemical methods.

The importance of these experiments, which will be completed only after a number of years, induces me to mention at least their cardinal points with a few words.

Jordis and Kanter, realizing that the study of the element silicium had been neglected, started, in 1902, an exhaustive research of silicic acid and its salts. These laborious experiments are hoped to result in some general conclusions applicable also to the chapter "Portland cement."

On the other hand, Richardson published, in 1903, results of experiments about "alloys" of pure and mixed silicates, aluminates and so forth. These tests have partly been finished. If completed, they will undoubtedly supplement the researches of Jordis and Kanter in an effective way.

The present paper shall serve to demonstrate the possibility of another and simpler method of advancing our knowledge about cement. The contemplation leading to these experiments was briefly the following:

In contrast to former investigations, which were almost exclusively based upon material burnt only to a point of vitrification, corresponding with the process of cement burning used in actual practice, my examinations were made upon material heated to a temperature at which it fused completely. The object of this was to render all constituents active. Such high temperatures were reached by the electric furnace. The main point in view was to determine in every instance, whether well-defined compounds were obtained. Such a determination had been often neglected in previous observations. A special study was made of all crystallized products obtainable. In the course of these experiments it was found necessary to gradually simplify the composition of the products in order to exclude all factors of secondary importance.

I thus succeeded in producing a cement, the properties of which solely depended upon its chemical composition. This enabled me to establish general rules for the valuation of cements. Furthermore, crystals were obtained of such size that they could be isolated and subjected to chemical and mineralogical analysis more readily than, for instance, the crystals formerly observed in vitrified Portland cement.

It could be determined that fused mixtures of silica and calcium oxide were possible, which contained one molecule of silicic acid to three molecules of calcium oxide. However, whether or not this product represented a chemical compound, a tri-calcium silicate ($3\text{CaO}, \text{SiO}_2$), could not be proven.

Further experiments showed that the alumina in cement could be replaced by other oxides of metals. For instance a crystallized product was obtained composed of calcium oxide, silica and chromium oxide, in which calcium oxide and silica were contained in the molecular proportions of 3 to 1.

The crystals obtained in the course of this research work may possibly be suitable for the study of the hardening process of Portland cement; yet, this latter point shall be dealt with only briefly in this paper.

I. PRINCIPLES UNDERLYING INVESTIGATIONS OF CEMENT:

Researches made before Le Chatelier: In the following the various ways shall be described, in which experimenters tried to explain the constitution of cement, and it shall be shown what general conclusions could be drawn from their observations. It will be pointed out, why often contradictory statements have been made about the same subject and upon what principles the various theories have been based describing the origin of the compounds contained in cement and their combination with water.

Jordis and Kanter have published a very comprehensive list of essays pertaining to cement. Unfortunately, this enumeration is not clearly arranged. Their brief critical remarks, declaring a large number of these publications to be rather worthless, are justified in most instances; however, their criticism goes certainly too far in many cases, while in others their harsh condemnation is not sufficiently supported by facts.

In the following I shall endeavor to review especially researches deserving a general interest on account of the methods followed and the results obtained:

Vicat was the first who, in opposition to the guesswork done before him, seriously took up the study of the properties of cement and who placed the manufacture of hydraulic lime on a scientific basis. He started his experiments in the year 1812. During a period of 14 years he analyzed 83 different kinds of hydraulic lime and studied their behavior in the burning process and their action in contact with water. This enabled him to make the definite statement "that no perfect hydraulic lime could be found without silica and that all grades of lime, possessing hydraulic properties, upon chemical analysis are found to contain a certain percentage of clay consisting of silica and alumina in proportions similar to those of ordinary clays."

At the same time he produced artificial hydraulic lime by burning various mixtures of ordinary slaked lime and clay. These experiments made Vicat not only the originator of cement research-work, but also of cement manufacture on a scientific basis.

In 1823, **Berthier** continued the work of Vicat and tried, in a rather primitive way, to obtain by synthesis the chemical compounds which might possibly be contained in hydraulic limes. He heated at comparatively low temperatures mixtures of chalk and colloidal silica in different proportions and obtained from a burnt mixture of 10 grams of chalk and 4 grams of silica a powdered product possessing all the characteristic properties of hydraulic lime. He agitated this powder with a surplus of water and discovered that a part of it went into solution. The lime thus dissolved he called free calcium oxide, and from the remainder he figured out the composition: 35% CaO and 65% SiO₃. It is surprising that these figures correspond approximately with the formula CaO, SiO₃ of his days.

Furthermore, Berthier arrived at the conclusion that calcium oxide and alumina resulted in a compound which was completely decomposed by water. In his opinion, alumina increased the strength, if it was present in about the same amounts as silica, whereas iron

oxide and manganese oxide did not contribute to the hardening. He found a large percentage of manganese oxide to prevent the hardening, even in cases, in which corresponding amounts of calcium oxide and silica would have yielded a fair hydraulic lime. These results obtained by Berthier were confirmed by Vicat in 1823 after the latter had investigated the subject independently.

In 1856, **Rivot** and **Chatoney** made some observations on English Portland cement, which must have differed from the present day's product, as Rivot, to whom we owe the chemical part of the report, found in it coarse glassy particles of rather large size which he separated. He assumed a difference to exist between the fine and the coarse, but could not prove this assumption by chemical analysis. Also he believed to be able, in the same way as Berthier did, to extract the free lime and calcium oxide combined with sulphuric acid by a large amount of water. For the residue he found approximately the formulae:



The first of these corresponds with the modern formula 2CaO, SiO_2 . In the case of a quick-setting natural cement from Vitry-le-Francais, however, he did not succeed in finding a chemical formula, especially not for the aluminate.

He likewise examined hardened mortars after careful separation of the sand and stone and arrived at the following conclusion:

"The percentages of alumina, iron oxide and magnesia are too small to influence the hardening and the stability of the mortars. The hydro-silicate is without doubt the sole active substance and its composition ought to be ascertainable very closely by taking the average of 14 analyses made by him."

For quick-setting cement he found the composition: $3\text{CaO, SiO}_3, 6\text{H}_2\text{O}$ equal to $2\text{CaO, SiO}_2, 4\text{H}_2\text{O}$ and for ordinary Portland cement $3\text{CaO, SiO}_3, 3\text{H}_2\text{O}$ equal to $2\text{CaO, SiO}_2, 2\text{H}_2\text{O}$.

Rivot, as the first, doubted the correctness of the method employed by Berthier and himself of extracting the "free lime" and gypsum by means of water and admitted, that possibly the large amount of water used carried also part of the calcium oxide into solution which was combined with alumina and silica.

During the last 20 years of cement researches a great number of writers on the subject have energetically declined to recognize any experiments based upon a decomposition of cement by water or by chemicals dissolved in water. In spite of this, even our modern literature contains descriptions of similar methods and results.

Fremy (in 1865) made the following statement: "The setting is due to two different chemical reactions, in the first place, to the hydration of the calcium aluminates and, in the second place, to a puzzuolana-like process by which the calcium hydrate combines with the silicates."

These views were based upon his failure, in spite of several series of experiments, to obtain a calcium silicate or a double silicate containing alumina and calcium oxide, which would set under water. He, furthermore, proved the alumina to be an excellent means of fusing calcium oxide by preparing mixtures of both substances in varying proportions. Of these he was able to bring to the point of fusion a mixture containing as much as 98% of calcium oxide. Calcium aluminates answering the formulae $\text{CaO, Al}_2\text{O}_3$; $2\text{CaO, Al}_2\text{O}_3$ and $3\text{CaO, Al}_2\text{O}_3$ he found to set in contact with water and to cement foreign substances as, for instance, crushed quartz. The fact that Portland cement required a high burning temperature he attributed to the circumstance that the calcium aluminates

hardened the better at the higher a temperature they were produced.

In his opinion, Portland cement had to contain a certain percentage of free lime. On the other hand, free lime could be likewise obtained by the decomposition of calcium aluminates in water. For this reason he examined a great number of substances with the object of ascertaining, whether or not they would act as puzzuolanas in contact with calcium hydrate and water: but he found the number of such substances to be very limited. As the most active substances he recognized calcium silicates possessing enough of a base to precipitate gelatinous silica upon decomposition with acids. Silicates of this nature he firmly believed to be present in cements and thus he thought to have sufficiently explained the part which the silicates and the calcium oxide took in the hardening of cement.

A few years later Fremy limited his theory by declaring the hardening to be due solely to a "puzzuolana-like reaction."

The foregoing represents a brief outline of the development of research-work done in France from Vicat until Le Chatelier. This group of investigators had to be discussed at a time, as one continued the work of the other, and as none of them, with the exception of Vicat, took notice of what had been accomplished in the meantime by other nations. Also Le Chatelier, in his fundamental essay, which shall be discussed in detail afterwards, never referred to a German scientist, although a comprehensive literature on the subject had developed in Germany at the same time.

About at the time of Vicat's first paper an essay was published by John in 1819 which compared very favorably with the former. The result was that "calcium oxide was able to precipitate silica from alkali-silicate solutions." This fact he presumed to be applicable to the formation of mortars. As a result of many analyses made of mortars 100 and 600 years old, and even of an ancient Roman mortar, he discovered that the carbonic acid never sufficed to neutralize all calcium oxide, but "that part of the calcium oxide was really combined with part of the silica or alumina and a small amount of iron oxide present, or with all three elements, in exactly the same way as these substances are found to be combined in natural minerals."

This paper, therefore, contradicted the theory prevailing at that time to the effect that the hardening was due to the regeneration to limestone by absorption of carbonic acid. John, however, rejected his own theory later, after having failed to observe the slightest loss upon imbedding crystal of quartz, sapphire and garnet in lime-paste for half a year or upon having boiled them with lime-paste for 3 hours. This observation induced him to declare that the sand and stone, mixed with the cement, do not take any part in the hardening; he even extended this statement, in opposition to Vicat, upon sand containing clay and upon puzzuolana. A series of analyses of hydraulic lime, made before and after calcination, determined him subsequently to ascribe an important part in the hardening "to the compounds of calcium oxide and silica, alumina and iron oxide formed in the course of the burning process." Starting out from this observation he produced by and by, similar to Vicat, artificial hydraulic limes by admixing clay to pure limestone.

John's work seems to have fallen into oblivion; at least most investigators succeeding him refer to Fuchs, whose publications date from 1829 and 1830, and who examined which modifications of silica were capable to produce cements, and designated as cement a "substance hardening with lime under water." He con-

cluded "that calcium hydrate in contact with water combined with silica and with many silicates, even if the latter contain a large percentage of calcium oxide, and rendered them active." This process he called "wet cementation" and attributed to it the hardening under water. He believed compounds to have been formed by the action of slaked lime upon these substances and regarded as a proof of it the fact, that silica itself and certain silicates, which would otherwise not gelatinize with acids, yield gelatinous silica in contact with acids, after having been mixed with lime-paste and kept under water for some time. The highest limit of absorption of calcium oxide seemed, in his opinion, to coincide with the composition of wollastonite.

The synthetic experiments which Sefstroem and his scholars conducted in 1827 were not fully appreciated. The objection was made that all hydraulic properties were lost at the high temperatures employed; in fact, he made use of a blast furnace with which the temperature of melting platinum (1770 centigrade) could be obtained. These experiments were made in order to observe the phenomena accompanying the reduction of iron; but unfortunately the behavior of the preparations towards water was not studied.

The calcined products obtained were: CaO, SiO_2 , and $2 \text{CaO}, 3\text{SiO}_2$, of which the latter fused more readily. At the attempt to produce highly basic silicates, up to $2\text{CaO}, \text{SiO}_2$, disintegration of the products upon cooling was observed. As the percentage of calcium oxide could be increased in the mixtures only, if at the same time alumina was added, he concluded that the alumina acted the part of an acid in the burning of cements. In order to demonstrate this, he likewise burnt the following aluminates: $3\text{CaO}, 2\text{Al}_2\text{O}_3$; $\text{CaO}, \text{Al}_2\text{O}_3$ and $3\text{CaO}, \text{Al}_2\text{O}_3$. The last named crumbled into dust after several months.

As, in accordance with Fuchs' observation, wollastonite was unable to take up additional calcium hydrate and for this reason did not harden, Pettenkofer (in 1849) concluded from this, that the calcium oxide must not combine with silica in the burning process or only with small amounts of it. "This," he said, "can only be prevented, if the silica is sufficiently combined with basic substances to which it has a greater affinity at high temperatures than to calcium oxide. As such I designate principally alkalis, then alumina and iron oxide." During the hardening process he assumed the alkalis to be washed out by the water and the calcium hydrate to take their place; thus the formation of calcium silicate would be brought about which, in his opinion, was essential for the hardening. This theory, of course, assumed the calcium oxide, or its greater portion, to be in an uncombined state. That, notwithstanding this fact, the lime did not act more energetically, was attributed to the circumstance that it was enveloped by a film of sintered clay.

In 1856, Winkler called attention to Fuchs' experiments, which were made exclusively with Roman or natural cement, and, in opposition to Pettenkofer, who applied Fuchs' hardening theory also to Portland cement, claimed this latter to possess chemical properties of its own, though the product resulting from the hardening process was the same as in the case of Roman cement. A cement, which showed no development of heat upon addition of water, in his opinion, contained all calcium oxide chemically combined. He, furthermore, contradicted Pettenkofer's statement that the free calcium oxide was enveloped by sintered clay, as this would inevitably give rise to the formation of calcium aluminate, and proved this by experiments in which he burnt mixtures of calcium oxide and alumina or iron oxide. In addition to this, Winkler proved

that the water could continuously wash out calcium oxide out of a cement; yet, he believed that this would reach an end, as soon as the compounds CaO , SiO_2 and CaO , Al_2O_3 were obtained.

He arrived at the same formulae through his investigations made on the compounds formed during the hardening process of Portland cement by extracting the calcium hydrate with a solution of crystallized ammonium nitrate in concentrated alcohol and determination of the residue. Besides calcium hydrate, also a small amount of alumina went into solution in the course of this process. The test on the accuracy of the reagent employed gave satisfactory results in as much as calcium hydrate went readily and completely into solution, whereas only a trace of calcium oxide, contained in chalk, was dissolved, and also a relatively small amount of the calcium oxide could be extracted from Portland cement.

Feichtinger (in 1859) declared the greatest part of the calcium oxide in a cement to be free. He made extensive tests in order to determine, in hardened cements, the amount of water combined with the silicates and that required for the calcium oxide. The water combined with the silicates was supposed to evaporate at 300 centigrade, while that chemically combined with calcium oxide could be driven off only at higher temperatures. Perfect hardening he pronounced to necessitate the following three chemical processes: 1. Combination with water. 2. The hardening proper caused by the combination of calcium hydrate with silica and with the silicates present. 3. Transformation of the calcium hydrate, not needed in the hardening process, into calcium carbonate.

In 1864 he attacked Winkler's theory by demonstrating that a cement, after extraction of its calcium oxide by means of ammonium carbonate, obtained again the ability to harden upon admixture of calcium oxide, which would have been out of the question according to Winkler's theory.

The following year witnessed a lengthy debate between Winkler and Feichtinger on the subject, whether or not a large amount of the calcium oxide in cement was in an uncombined state. This question is still open to discussion at the present day.

In 1863, Zulkowsky published his first essay on hydraulic cements. Also his theory was based upon the existence of a large amount of free lime in cement. This latter question, however, will be taken up later and be discussed in detail; for this reason we had better postpone a description of his experiments until then.

Heldt (in 1865) made a special study of the silicates. The calcium silicates which he obtained by burning did not harden; besides, all fused products he regarded as worthless without ever having examined them. In the presence of water, by treating calcium hydrate with concentrated alkali-silicates, he succeeded in producing a hardening compound of the composition $5\text{CaO}, 3\text{SiO}_2$. This he declared to be the "effective compound in all hydraulic cements." The compound CaO , Al_2O_3 did not harden in his opinion. About other aluminates he made the remark, "that it did not matter, whether a cement contained $\text{Al}_2\text{O}_3, \text{CaO}$ plus 1 mol. of free calcium oxide or $\text{Al}_2\text{O}_3, 2\text{CaO}$, or, furthermore $\text{Al}_2\text{O}_3, 2\text{CaO}$ plus 1 mol. of free calcium oxide or $\text{Al}_2\text{O}_3, 3\text{CaO}$ and so forth, as these compounds or mixtures would combine with the same amounts of carbonic acid and water. Only the time of hydration would be different"

(To be continued)

THE NEW ROCKY MOUNTAIN PORTLAND CEMENT PLANT.

The Rocky Mountain Cement Co., of Blairmore, Alberta, recently completed, is now in operation. This company was incorporated during November, 1906, with a capitalization of \$600,000, with a 6 per cent. bond issue of \$400,000. Over \$300,000 of stock and \$100,000 of bonds still remain in the treasury. This company is an independent concern, not being connected with the big merger recently organized. The shareholders of the company are local men, as well as representatives in Eastern Canada, England and the United States. The company began work shortly after its incorporation, but had many difficulties in reaching the present stage. The following are the Board of Directors: President, William Codd, Spokane, Wash.; vice-president and general manager, W. J. Budd; secretary-treasurer, W. B. Reilly, and directors, John George, M. Mackenzie, P. Lind and T. W. Gordon.

The plant at the present time has a capacity of 500 barrels per day, and it is expected that this will be increased to 1,000 barrels per day next summer. There is one kiln so far 99 ft. 11" and later on they expect to add another. The plant is operated by line shaft, one being about 300 feet long. The rock comes through a No. 5 Gates Gyratory crusher and Williams mills. Lehigh Fuller mills are used on the raw and finish end. The power plant consists of three 150 h. p. Robbs boilers and a 500 h. p. cross compound condensing engine. Leather belting furnished exclusively by Chicago Belting Co.; Tisco manganese steel castings are used for replacing wearing parts. The company secure their coal from the Western Canadian collieries, which are situated about half a mile from the works. The price is \$2 per ton for mine run and considerably less for slack. The limestone, shale and coal are all within half a mile of the works. These products are procured from the side of Turtle Mountain, at the base of which the plant is situated. There is an abundance of excellent raw material, and the shipping facilities are of the best. The market for Portland cement is increasing very rapidly in the Canadian West, and the company are hopeful of making their plant one of the best in Western Canada. The analysis of the raw materials show the following percentages:

Analysis Raw Materials.—Limestone: Silica, 0.44; alumina and oxide iron, 00.12; lime, 53.46=95.87 carbonate of lime; magnesia, 1.70; loss on ignition, 0.

Shale or clay: Silica, 65.72; alumina and iron oxides, 19.20; lime, 2.00; magnesia, 2.04; alkalies, 1.20; loss by ignition, 9.84.

The company also manufactures lime and arrangements are now being made to erect another large lime kiln to meet the ever-increasing demand for their lime. With the erection of the new kiln the daily capacity of their lime-burning kilns will be about 1,000 bush. of lime per day. This lime finds a ready sale, a large quantity being shipped to Spokane, Wash., where it has to meet the competition of local works near Spokane, which, after paying the duty, speaks very highly of the quality. All the buildings and general plan of these works have been prepared for a 2,000-barrel plant, which the company ultimately hopes to have in operation.

The year 1910 promises to be a big year in all building materials, in the West, especially in cement, as the railways and the Government have extensive undertakings on hand calling for a large amount of cement.

THE NEW PLANT OF THE RIVERSIDE PORTLAND CEMENT CO.

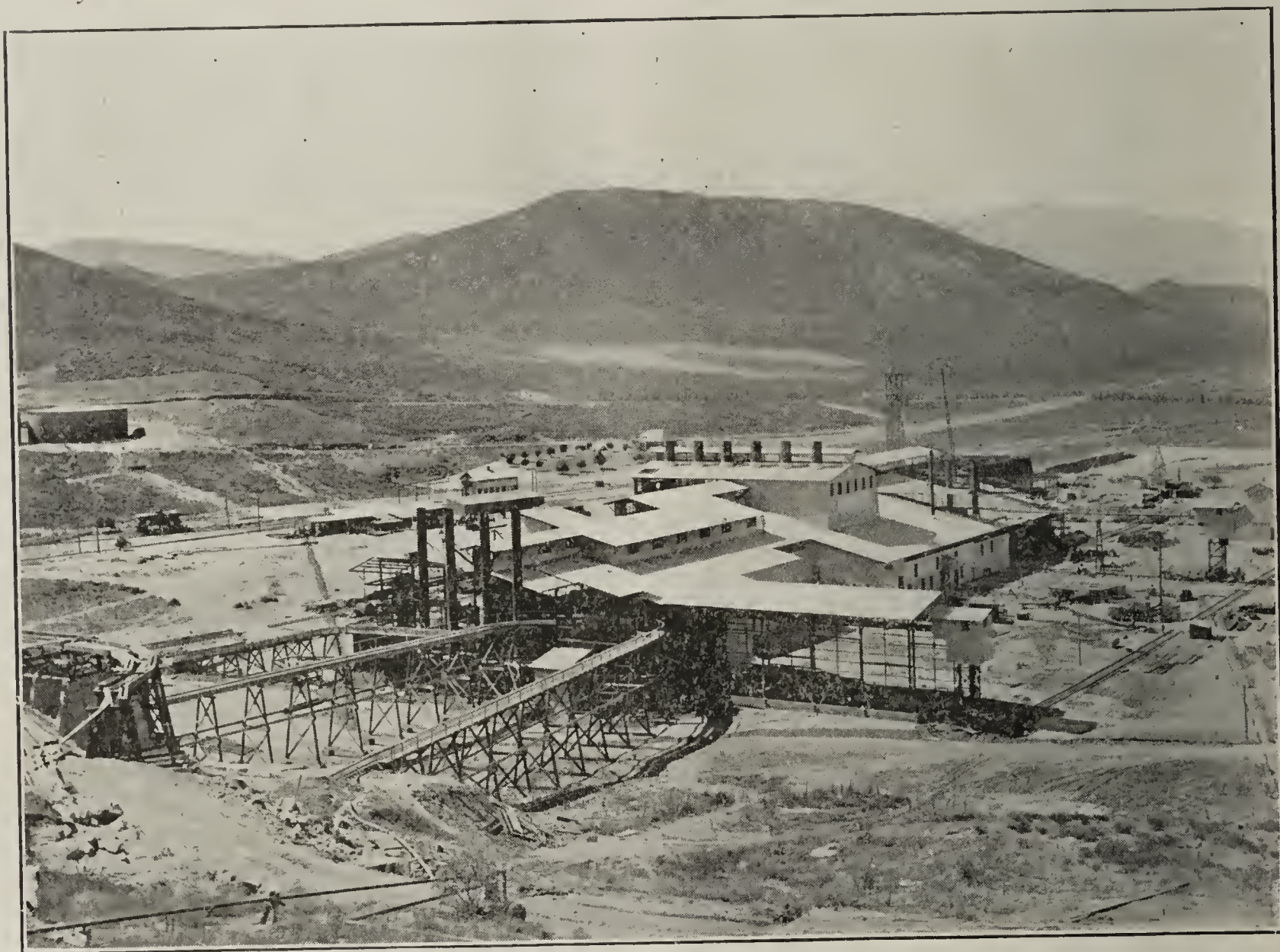
The Southwest now has on its markets another Portland cement, the product of Southern California's second cement plant, that of the Riverside Portland Cement Co. This cement is known as "Riverside Brand," and shipments have commenced several months ago. The plant at Crestmore, four miles northwest of Riverside, is now in operation and has been making clinker since December 25.

The aim of the Riverside Portland Cement Company is to turn out a product that will be absolutely uniform. Its finished cement will be stored until after the 28-day test has been made and no cement will be allowed to go out the storage bin until after this period has passed.

The Riverside Portland Cement Company, which until recently was known as the Southern California

throughout. The buildings are of reinforced concrete and steel. No frame construction has been used anywhere, hence durability and escape from the danger of fire loss has been attained. The mill has been made modern in every detail and the engineers have taken advantage of all the latest and best mechanical devices for turning out a product of the highest quality.

The capacity of the mill is 3,000 barrels daily. All machinery, as soon as installed, has been operated sufficiently to secure proper adjustment and relieve the stiffness incidental to all new machinery, so that when clinker manufacture was started, the whole plant operated as smoothly as an old mill. This preliminary operation of all bearings is but one feature of the systematized scheme of operation which promises to give the management an advantage in manufacture and upkeep that will in return give the cement user the benefit of both economy and consistent, careful, thorough methods. The processes of manufacture are conducted with thoroughness, certainty and an attention to every minute detail



Birdseye view of the Riverside Portland Cement Company's Plant at Crestmore, Riverside County, California, just before completion.

Cement Company, owns exclusive deposits of limestone and clay which chemical analysis has proved to be of the very highest grade for the manufacture of Portland cement. The supply of raw materials has been found, after careful drilling, to be sufficient to keep a 5000 barrel plant in operation for fifty years. Knowing what its raw supply was before construction plans were laid and having a profound faith in the future of the Southwest, the company decided upon a plant that from the standpoint of both economy in operation and durability should be second to none in the country.

The construction is heavy, substantial and fireproof

which make the operation of the plant of the most advanced modern type.

The raw materials used are a crystalline lime rock and clay. The limestone is within 400 feet of the McCully crusher and the clay within 600 feet. A reinforced concrete storage bin has been built on the quarry slope with capacity sufficient to take care of the quarry's output for a day of 10 hours, should the crushers be shut down momentarily for any reason, hence the quarry force can be kept in operation to the end of the working day, independent of the mill. The dumping track into this bin is on a level with the outlet floor of the quarry, facilitating economy in handling.

The stone is delivered from the quarry to the mill by cable cars, to a number 8 McCully crusher and then to two number 4 McCully crushers as secondaries. The operation of the crushers requires the attention of only two men, all materials being handled in the most economical mechanical way automatically wherever possible. After being crushed the stone passes through two 6 feet by 60-foot dryers, either to the ball mills or stone storage. The stone storage has a capacity for fifteen days' run. The material is handled from the crusher to the dryers and storage by a McCaslin conveyor. The preliminary grinders are Krupp ball mills.

The clay comes into the mill from the clay deposit in side dump cars made by Western Wheeled Scraper

tors were furnished by H. W. Caldwell & Sons, Chicago, Ill.

All processes of manufacture, from crushing to finishing, are conducted under one huge roof of corrugated iron supported by steel frame. This building is about 1200 feet in length, with concrete floor, the clinker kilns being located about the center. All departments are separated by concrete block partitions, motors and accessory machinery being fully protected from dust in closed compartments. The smoke, gases and dust from the kilns are caught in large chambers before being allowed to pass through the stacks into the outer air, and the dust retained. The management reasons that the handling and quarrying of its raw materials makes it too expensive to lose any portion of its raw supply through allowing the dust to escape and hence has taken every precaution to confine and save it. Then, too, the elimination of the dust question saves wear and tear of motors and machinery and hence furthers the policy of reducing the cost of up-keep of the plant. The plant is unusually free from floating dust, as is the atmosphere surrounding the entire plant.

Tisco manganese steel castings are used exclusively for replacing wearing parts.

The stock house is a separate building possessing interesting construction features. It is a reinforced concrete structure, 65x220 feet and 30 feet high, with hopper bottom and corrugated iron roof supported by steel frame work, which also carries the conveying machinery from the finishing mills. It has a total capacity of 100,000 barrels and is divided into bins with 5000 barrel capacity each. Caldwell screw conveyors at either side convey the cement from the bin chutes to the packing room, where it is delivered into packing bins over the packers, of which there are six. The packing room is at the far end of the stock house away from the mill, and has a 5000 barrel bag storage. Eight cars may be loaded simultaneously. The company's own spur tracks and equipment handle the product from the plant to the railroads.

The stock house is so arranged that a purchaser may make tests of the stock of a bin, seal it and have

Co., Aurora, Ill., handled by electric locomotives. Shafts and tunnels are used for economical operation. The clay passes in the mill through the disintegrators, then through dryers similar to the stone, and either to the preliminary clay grinders or to clay storage as required. The clay storage has a capacity of twenty days at 3000 barrels per day. The material, after being ground in the ball mills and the preliminary clay grinders, passes to the bins, over automatic weighing machines, thence to the mixer, thence to 5 feet 6 inches by 22 feet tube mills, and then to the kiln bins, where it is fed into six 8 feet by 100 feet Krupp kilns, each with 500 barrel daily maximum capacity.

The clinker passes from the kilns into a McCaslin conveyor, manufactured by Mead, Morrison Mfg. Co., New York, N. Y., which conveys it to two 6 feet by 50 feet rotary collers, or to clinker storage. The clinker storage has a capacity of 100,000 barrels. This same McCaslin conveyor handles clinker from the storage to the finish mill, by the intervention of a belt conveyor, in which case the coolers are shut down. The clinker is discharged either from the coolers or the conveyor to a weighing machine, where the gypsum is added, then to a battery of Krupp ball and tube mills, and then to the stock house, through a covered concrete tunnel.

The leather belting throughout the entire plant is of the best material and was furnished by the Chicago Belting Company. The screw conveyors and eleva-



Crushed stone at the Riverside Cement Plant handled from the crushers to the dryers and storage by a McCaslin conveyor.



The McCaslin Conveyor, conveying clinker.

it packed and shipped under his own inspector's supervision. In such case this stock is handled from storage to packing room by the conveyor on one side of the stock house exclusively, while the conveyor on the other side is used for other shipments.

The mill is electrically driven throughout, all wires being protected by conduits. All the larger machines are operated by individual motors of the alternating current type each 100 h. p., and of the heaviest construction. Compressed air is piped through all parts of the buildings and is used in cleaning the motors. There are 24 motors. The electric energy is received at the plant at 33,000 volts. The transformers are housed in fireproof compartments.

The auxiliary buildings consist of a machine shop, blacksmith shop, stock house, oil storage, roundhouse, time office, office and laboratory. Economy is gained in having the oil, which is used for fuel in the kilns, delivered from the cars and thence to the place of consumption, by gravity.

The tanks have 60,000 barrel capacity. The oil is delivered under pressure to the burners, and is heated in a separate plant in the main building before being consumed. The machine shop is fully equipped and has been utilized to good advantage during the construction period. All spouts and accessories, which are of iron throughout, have been made here.

The compressor plant consists of four machines furnishing 8000 cubic feet of air per minute, three furnishing 5-lb. pressure and one giving 85-lb. pressure for the quarries. The water pump is operated by compressed air, water being obtained in more than sufficient quantities from wells.

Three camps, each with its commissary department, are maintained by the company, one for white men, one for Italians and Greeks and one for Mexicans. Through its able policy in handling its laborers, the management has been singularly fortunate in maintaining amicable relations among its different classes of employees.

The mill is connected by a steam road to the Salt Lake, Southern Pacific and Santa Fe railroads. Suburban trolley cars run past the works, giving an hourly service to Riverside.

The company also operates a crushed stone plant as a separate industry, furnishing both porphyry and lime rock for concrete work. The plant is now being increased to 500-ton per day capacity. This rock is being used exclusively by the city of Riverside on its extensive good roads improvements, and is available for shipment to Los Angeles and elsewhere.

A bit of the history of this new California cement industry may not be amiss. The properties were first exploited in a small way as the Sky Blue Marble Works and were later taken over by the Lily White Lime Quarries company, which latter industry achieved considerable renown for its product. In 1906, Mr. William G. Henshaw, and Mr. Tyler Henshaw obtained possession of the properties and began an exhaustive investigation of the nature of the deposits. Mr. Henshaw's engineers sank 23 diamond drill holes to a depth of 270 feet. Finding the deposits both extensive and of the highest quality, Mr. Henshaw organized the Southern California Cement Co., whose stock is held by Los Angeles and San Francisco men. Mr. H. W. Keller of Los Angeles is vice-president and resident director. Mr. W. W. Poole is manager, under whose supervision the plans were prepared and construction work prosecuted. The selling campaign has been organized and will be directed by Mr. John G. Treanor.

ADVANTAGE OF AIR-SEPARATORS.

By D. E. Bogdahn.

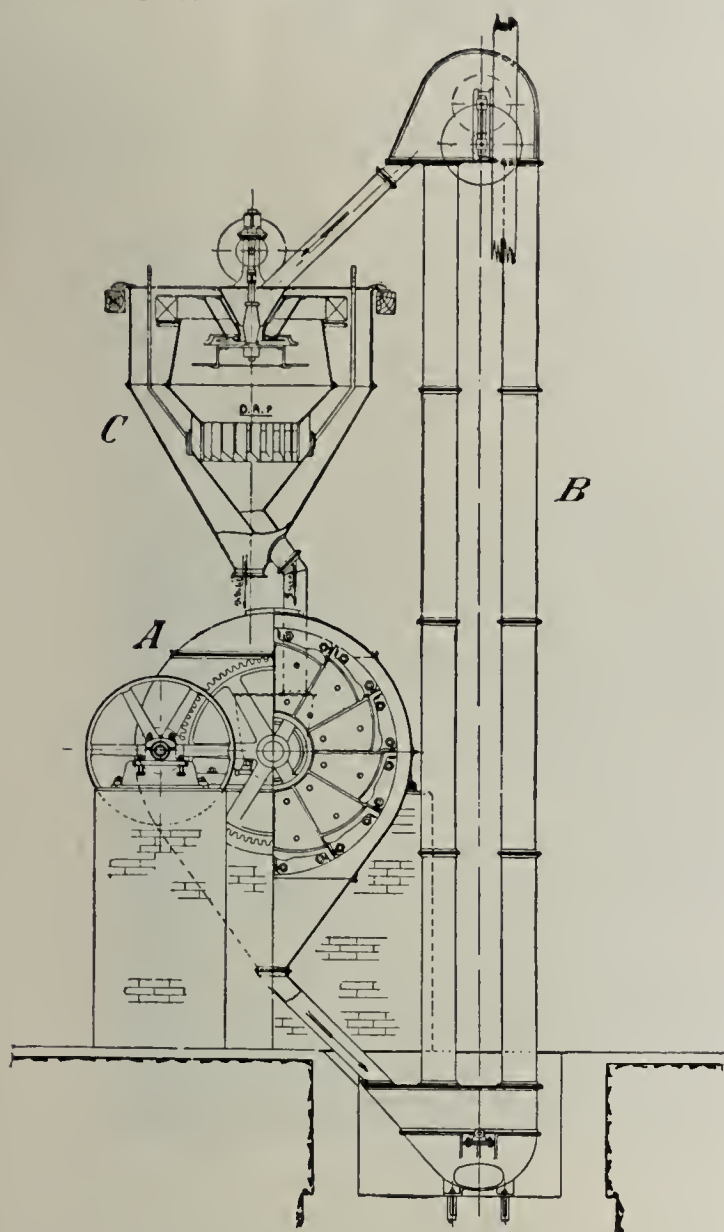
Frequently the opinion has been expressed that air-separators connected with grinding mills destroy the uniformity of the cement raw mixture. That similar statements are based merely upon prejudice or lack of theoretical reflection as well as want of practical experience shall be proven by tests to be reported later. Before doing so, attention is called to Mr. Meade's publication on the subject who emphatically attacks with the following words all remarks made to discourage the use of separators:

"A rather amusing discussion of the separator question appeared in one of the engineering magazines (Some of the Reasons why Separators are not Used in Portland Cement Works, by C. E. Eckel, Engineering News, vol. 51, p. 344), in which the author took the ground that the separators destroy the uniformity of the product and that for example in a clay-limestone mixture the lighter particles of clay would be blown away from the heavier limestone. The author seems to have overlooked the fact that by pulverizing the limestone particles a little more finely they too will be blown out by fans of the separator so that, while it may be true that on starting up a new separator the first product will be slightly over-clayed, the trouble will be adjusted by the return of the limestone to the grinder for finer pulverizing, after which it will be blown out on its next passage through the separator together with the clay from the new lot of mixture fed into the tube mill, the process being a continuous one. My own personal experience with air-separation at the plant of the Edison Portland Cement Co. convinces me that there is nothing against its use on the ground of lack of uniformity in the product."

After having convinced myself through careful experiments of the correctness of the foregoing statement, I installed Pfeiffer's ball-mills and air-separators at our plant. These have now been running continuously for about a year and thus permit me to draw some final conclusions. Our materials are a hard limestone containing 98% of calcium carbonate and a plastic clay carrying from 13% to 27% of calcium carbonate, which latter has to be quarried without paying any attention to high or low contents of carbonate of lime. Ordinarily only the clay is dried in rotary cylinders heated by the waste gases of the rotary kilns, whereas the limestone needs drying only in rainy weather. After having been dried, the clay represents a fine powder containing some small friable particles; the limestone, on the other hand, is very tough and hard to grind. Thus, our raw materials are of very different physical properties: therefore, the results obtained under these conditions deserve particular attention. Most cement manufacturers have undoubtedly materials less difficult to work with.

Our method of operating is the following: A mixture of 100 lbs. of limestone and 37 lbs. of clay is fed, by means of an automatic feeder, into the ball mill "A", in which it is ground to a certain degree of fineness. The ground raw mixture is then conveyed by the elevator "B" into the Pfeiffer air-separator "C". The latter separates the coarse from the fine and returns the coarse to the ball mill "A", which grinds it to greater fineness together with other material continuously fed into the mill. This process of returning of the coarse to the ball mill goes on until all of it obtains the desired fineness. As the composition of

the clay varies within 14%, as formerly stated, the finely pulverized raw mixture must necessarily show some variations.



Here follow the results of the determination of carbonate of lime in the finely ground cement raw mixture, made at regular intervals of about an hour in the course of four shifts:

1. Shift:			2. Shift:		
76.75 per cent. CaCO_3			75.50 per cent. CaCO_3		
77.00	"	"	75.25	"	"
76.25	"	"	76.00	"	"
76.50	"	"	76.75	"	"
76.75	"	"	75.75	"	"
76.50	"	"	76.50	"	"
77.25	"	"	77.25	"	"
77.50	"	"	77.50	"	"
78.00	"	"	77.25	"	"
77.75	"	"	76.00	"	"
76.50	"	"	76.50	"	"
76.00	"	"	76.75	"	"
3. Shift:			4. Shift:		
76.75 per cent. CaCO_3			75.25 per cent. CaCO_3		
77.50	"	"	75.25	"	"
78.00	"	"	74.75	"	"
78.00	"	"	75.00	"	"
77.50	"	"	75.50	"	"
77.25	"	"	76.00	"	"
76.75	"	"	76.25	"	"
76.50	"	"	76.50	"	"
76.50	"	"	76.50	"	"
76.25	"	"	76.75	"	"
76.75	"	"	77.25	"	"
76.00	"	"	77.25	"	"

These tests were made on single samples taken quickly from the separator, hence do not represent an average of a number of samples taken for a minute or even for a fraction of this time. They show smaller deviations than should be expected theoretically. Thus, the air-separator does not only not

destroy the uniformity of the raw mixture, but even improves the composition of it. The foregoing determinations show that the raw mixture never deviates more than 1% in carbonate of lime from the average composition as furnished by the separator, whereas from the varying composition of the clay a deviation of 1.75% in carbonate of lime has to be expected. I doubt, if by any other devices as favorable results can be obtained under these circumstances without resorting to expensive and cumbersome installations as silos for crushed limestone and dried clay, automatic scales and so forth; and even a similar complicated installation is apt to become the source of much trouble; for instance, if a silo does not discharge its contents regularly or if scales are out of order, it happens that only limestone or only clay is ground for a time. Of course, a ballmill has likewise to be fed regularly, which can be accomplished easily by an automatic feeder and on account of the simplicity of the installation; otherwise it would yield varying percentages of carbonate of lime, no matter whether it is coupled with an air-separator or a tube mill, and the latter, in addition, would turn out material differing in fineness.

By the publication of the foregoing tests I trust to contribute some information to the general knowledge about air-separators, against which a prejudice existed among some manufacturers. Also the grinding of rotary kiln clinker and coal with this combination of ball mill and Pfeiffer air-separator gave the same satisfactory results.

PRODUCER GAS FIRED FURNACES.

According to a statement contained in a new book published by a consulting engineer and expert on "Producer Gas Fired Furnaces," Mr. Oskar Nagel of New York, "there is no difficulty in producing with coal gas the temperature required for cement burning."

Although Mr. Nagel does not mention cement plants or describe installations, in which producer gas has actually been used for burning cement, we have heard of late of similar attempts and feel confident that in time all difficulties, that have been encountered so far, will be overcome and that, by sufficiently preheating the air entering the kiln or by admixing liquid fuel of high heating value, the desired temperature will be obtained.

The subject, which the author has chosen, is very timely and of interest to every cement man, as the next years will undoubtedly develop a great number of rotary kiln installations fired with producer gas, especially at plants manufacturing white cements. The manufacture of white Portland cement, for instance, has proven to be a failure, as long as powdered coal was used, because the small amount of ashes dropping on the clinker was sufficient to discolor the product and to give it an unsightly greenish tint.

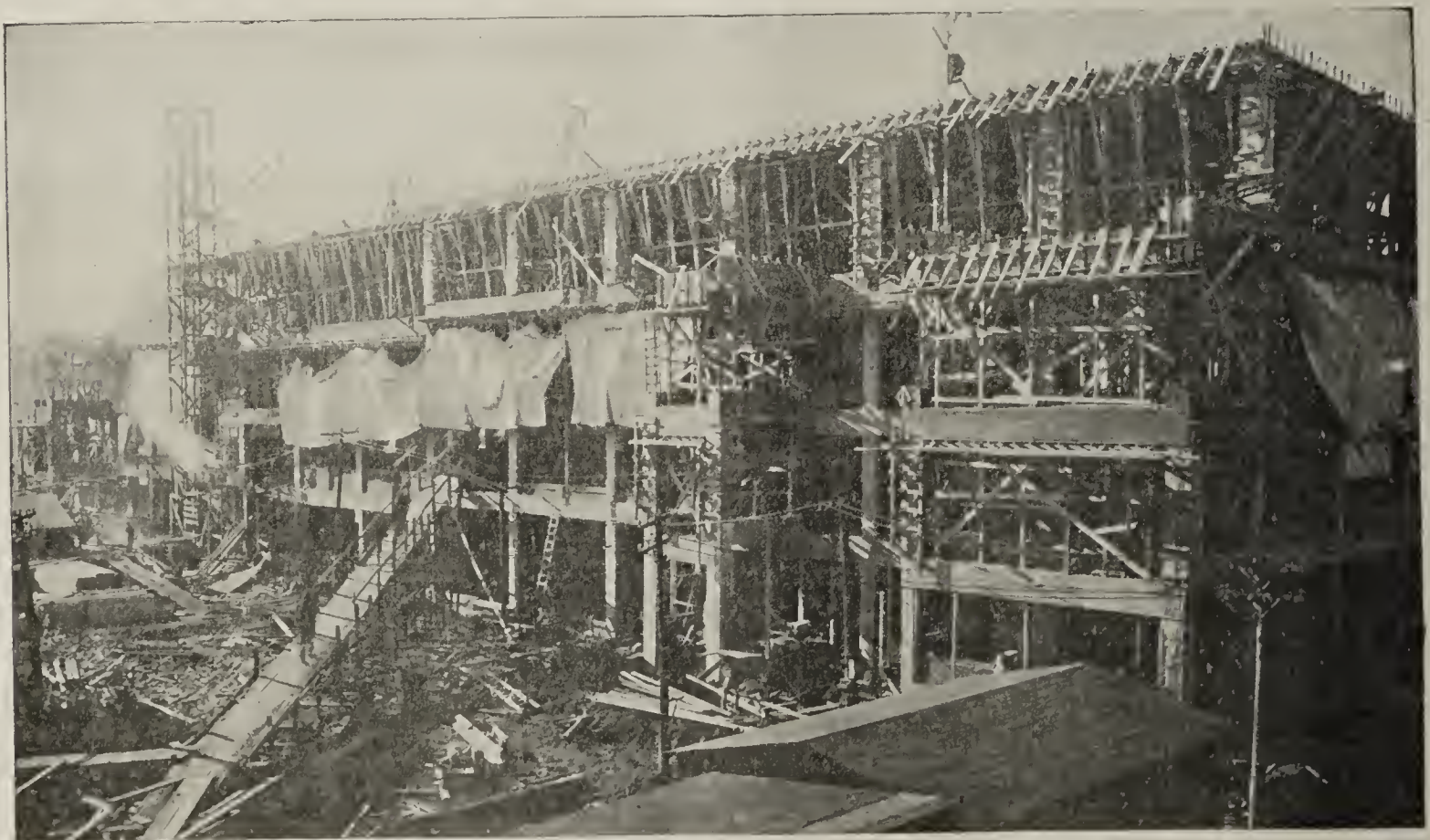
As Nagel's book "Producer Gas Fired Furnaces" describes in detail all systems of coal gas installations used in other branches of the chemical industry from the oldest type to the most modern designs, careful perusal of this literature will give to cement men, who are anxious to improve their burning system, valuable hints and will show them in which direction to look for improvements.

Three Months from Ground to Roof.

A RECORD IN REINFORCED CONCRETE CONSTRUCTION



The Third Week.



The Sixth Week.

A time record of swift, sound, scientific building in reinforced concrete for the Pierce-Arrow Motor Car Company by the Aberthaw Construction Co. of Boston, Mass. This record was made under very adverse weather conditions. The construction plant

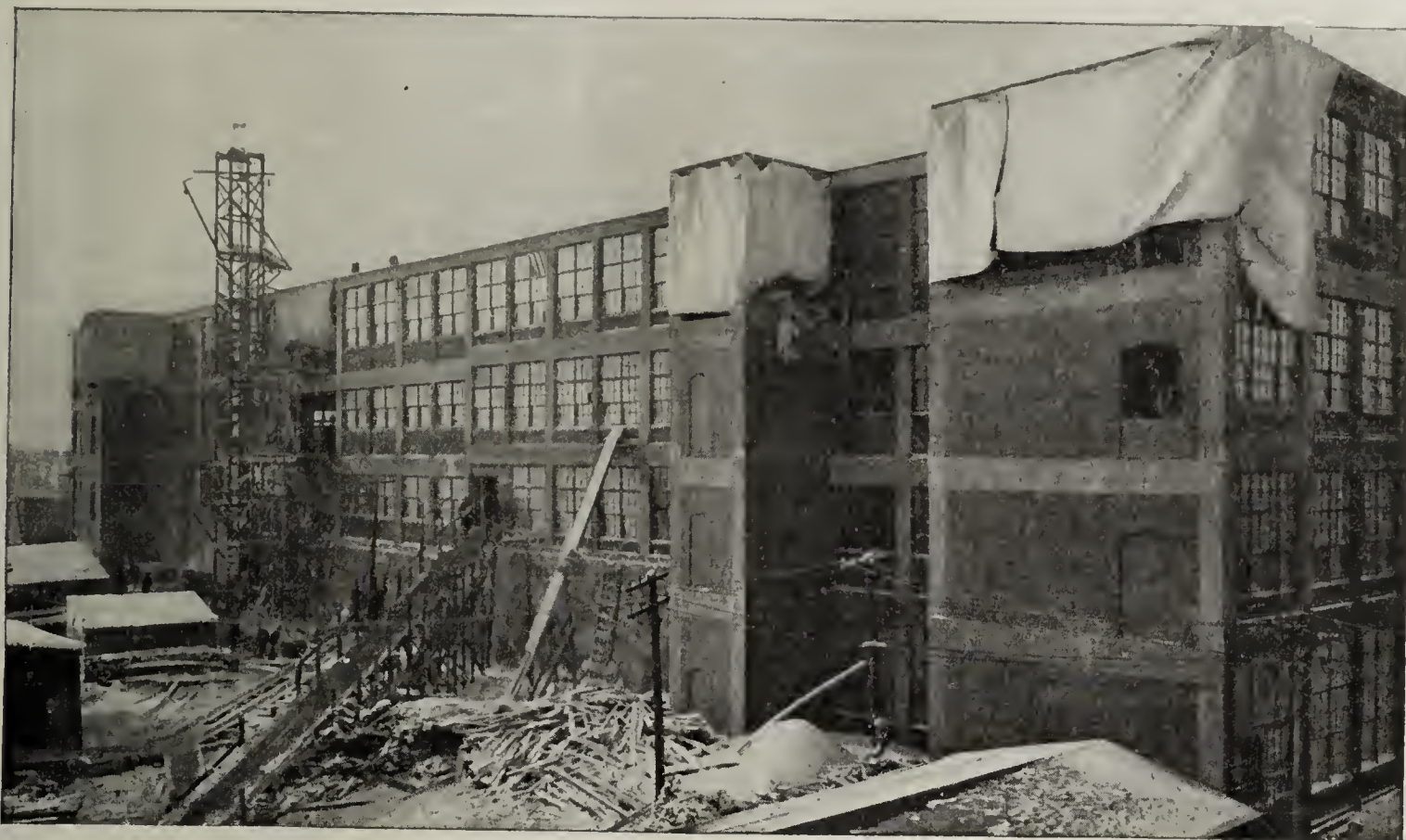
was arranged in such relation to the site of the work and the position of delivered material as to avoid all confusion and interference among the labor gangs and waste of time by unnecessary handling.

AN EXAMPLE OF RAPID WORK IN THE CONSTRUCTION OF A LARGE REINFORCED CONCRETE BUILDING.

A four story reinforced concrete building containing 107,500 square feet of floor space has been recently completed for the Pierce Arrow Motor Car Company,

creted and some of the forms stripped from the first story.

By December 1st practically all the forms were in place, and on December 7th, the concreting of the roof was finished. The building was closed in by the first of the year and was ready for occupancy Jan. 15th. The accompanying photographs show clearly the work as it progressed.



The Tenth Week.

of Buffalo, N. Y. This building was finished and delivered to the owners in three months from the time work started. The contract was placed with the Aberthaw Construction Company, of Boston, Mass., on Sept. 24th, 1909.

Three weeks of rainy weather followed, so that actual construction work did not begin until Oct. 15th.

On Nov. 1st the foundations had been completed,

The building, four stories, 308 ft. by 62 ft. with wing 105 by 51, and one story connections between the new and old building comprised about 10,000 square feet, has a skeleton, reinforced concrete frame, with brick curtain walls and mushroom floors and roof. The columns are spaced 20 feet 6 inches on centers, each way and the floors are designed to carry 150 pounds per square foot live loads.



The Completed Interior.

all the first story and about half the second story forms erected and the concreting of the first story about finished. Two weeks later the forms for the third story were nearly completed, the second story con-

The reinforcing of the mushroom column head consists of eight (8) 1 inch round steel bars extending down into the columns 4 ft. below the bottom of the floor slab; these are bent at right angles over a $\frac{5}{8}$ in.

by 2 in. band placed just above the bottom of the floor slab. The rods flare radially into the slab from this band and extend outward for a distance of 3 ft. 9 in., while two circles of steel rods 8 ft. 4 in. and 4 ft. 6 in. in diameter rest on the radial bars and are wired to them. The floor reinforcing bars extend well over each column head and run parallel and diagonal to the lines of columns.

The building is provided with two elevators and two stairways. The elevators and one stairway are in a fireproof tower in a corner adjacent to the assembly building, and the other stairway is in an exterior tower at the other end of the building.

Toilet rooms are placed in exterior stacks, so located on the outside of the building that they will form part of the future extensions and thus be able to serve these wings as well as the main building.

As this building may be used at some future date for manufacturing purposes, the question of machinery installation received careful consideration.

The absence of girders makes it possible to run overhead trolley tracks, heating pipes, or shafting in any direction desired. Through the center of each bay and extending the full length of the building, inverted U-bolts are placed at frequent intervals over the reinforcing rods of the floor slab of the story above, and extend four inches below the ceiling line.

Each bolt spans three reinforcing rods,—the exposed ends are threaded their entire length. For the present these bolts are to support trolley tracks but shafting can be supported very readily should it ever be necessary. The first and second stories have granolithic finished floors, and the two top floors No. 1 maple on 1 in. rough underfloor.

These top floors are very firmly locked down by 3x4 sleepers with beveled edges, which have $\frac{1}{8}$ in. x 2 in. x 12 in. steel bands fastened to their under side every 12 inches. The structural concrete was cleaned with a sand blast, the sleepers placed on 16 in. centers, running across the building, and the space between filled with a 1-3-6 mixture of gravel concrete.

One of the novel features which should be noticed is the construction of the pilaster flues which distribute the hot air of the indirect blower heating system from the tunnel underneath the ground floor to the second, third, and fourth stories.

The exterior concrete columns on one side of the building are cast with a channel-shaped cross section. The vertical risers leading to each floor are formed by bricking up the outside of these pilasters. Communication is had with each floor by means of registers and dampers.

The arrangement of the construction plant and the methods of handling materials are of considerable interest.

A spur track from the main line of the railroad was paralleled by an industrial track carried on trestles about the height of the car body. Except for stock piles or aggregate for use in case of car shortage, all sand, gravel, and stone was unloaded from freight cars directly into Koppel dump cars running in the industrial track to a switch which turned into the platform above the mixer mouth.

An elevator tower was located on one side of the building about 130 feet from the wing end and a Smith mixer with a capacity of 46 cu. yds. per hour was placed at the bottom.

The cement shed was located between the elevator and the railroad siding, the cement being unloaded directly from the cars into the shed at one end and taken out of the other end onto the mixer platform. The aggregate was dumped from the Koppel cars di-

rectly into the mixer mouth along with the cement. A tipping barrel was used to put in the water.

The mixer discharged into an automatic dump bucket designed by the contractor and this was hoisted to the desired level, and automatically dumped into steel V shaped concrete carts, thence hauled by hand to point of placement.

The steel was unloaded into stock piles, sorted as to size and separated as to position in the building.

When wanted this was carried to the foot of the elevator tower, hoisted to the proper floor level by a derrick seated on the elevator tower.

The bars were then dragged into place by hand, spaced evenly and wired together into sections so as to remain rigidly in place when concreting.

The forms were of very simple designs and made in units that could readily be handled by two men. The units were made of a few boards cleated together and they were intended to remain as a unit and to be transferred to the corresponding position vertically above. Cutting and fitting for special work was, of course, necessary, but as little loose timber as possible was used around the job.

In freezing weather the stone and gravel were heated by live steam at low pressure from the central power plant. There was a flexible steam connection with outlet which was buried in the material and the steam allowed to percolate through until it was hot enough to use. The water for mixing the concrete was heated by passing through pipes coiled in a salamander.

Lehigh cement was used throughout and the aggregate was largely dredged gravel, which proved exceptionally good concrete material. When the proportion of sand was excessive, it was mixed with some crushed stone.

The contractors were the Aberthaw Construction Company, and the architects, Lockwood, Greene & Company, both of Boston, Mass.

WORK TO START ON \$13,000,000 IRRIGATION PROJECT IN COLORADO.

The contract for constructing the largest irrigation project yet undertaken was awarded in Chicago on March 8 by the Colorado Southern Irrigation Company of Canon City, Colo., and A. J. Register & Co., of Philadelphia, to the Kenefick-Quigley-Hoffman Construction Company of Kansas City, Mo., at their bid of \$12,987,000.

The lands to be irrigated lie on both sides of the Arkansas River, beginning at Canon City and extending down to Pueblo, covering 400,000 acres.

This will bring under cultivation some of the finest lands in the west. The country surrounding Canon City is already famous for its apples, and this new project will add many thousands of acres to the apple orchards of Colorado.

The contract includes the building of twelve mammoth dams, ranging in height from 112 feet to 200 feet; excavating 160 miles of main canals and several hundred miles of laterals. Fourteen tunnels will be driven, the longest of which is to be one-half mile long and is located near Canon City. Four of the dams will be located in the mountains; three on Grape Creek and one near Salida on the Arkansas River. They will be built of concrete and of the most improved design of construction. The other eighty dams will be located below Canon City; they will be built of earth with concrete face and core walls.

All construction has been designed by Mr. W. H. Rosecrans of the Arnold Company of Chicago, under whose supervision as engineer the construction will be done.

The Kenefick-Quigley-Hoffman Construction Company, whose present western office is in the Century building, Denver, Colo., will soon establish a local office in Canon City and will commence the actual construction as rapidly as machinery and forces can be shipped in.

MAKING CONCRETE WATERPROOF.

By Ira D. Baker, M. Am. Soc. C. E., Urbana, Ill.

Concrete is very largely employed in many building constructions, and in some situations it is very important that it should be at least practically waterproof. There are several methods of rendering concrete more or less impermeable to water, some of which are simple and free to any one, and some of which consist in using secret or patented compounds. Of the former the simplest method consists in mixing hydrated lime or finely divided clay with the concrete, thus at least partially filling the voids or interstices in the concrete and decreasing the percolation of water. Another simple method consists in mixing powdered alum with the cement and dissolving ordinary soap in the water to be used in mixing the concrete. Although the latter materials have been used for more than 60 years as a wash for rendering masonry impervious to water, and although in recent years they have frequently been employed as ingredients of concrete to make the entire mass impermeable, the proportions to be employed and the reason for the effect seem to have had little or no scientific consideration, at least the proportions used in practice vary very widely. For the purpose of securing data for the use in the revised edition of the writer's *Treatise on Masonry Construction*, now in preparation, certain investigations and experiments have been made; and it is the object of this article to present these results more fully than can be done in the book mentioned.

Alum and Soap Waterproofing Compound.

To use the alum and soap method of decreasing the permeability of mortar or concrete, the alum in powdered form may be mixed with the dry cement or the sand, and the soap may be dissolved in the water employed in mixing the concrete; or both the alum and the soap may be dissolved in the water. The former is probably the safer method in practice, since with the latter method the water must be thoroughly stirred while the two are being mixed or the precipitate may form in large masses which it is practically impossible to break up; and further the water must be stirred continuously to prevent the compound from accumulating on the surface. These are conditions that it is not always easy to be certain of securing. However, the alum is more easily dissolved than the soap; and hence the alum may be dissolved in, say one fifth of the water and the soap in the remaining four fifths, and then the two portions may be mixed together, being careful to stir them as the mixing progresses. The alum and the soap combine and form a finely-divided, flocculent, insoluble, water-repelling compound which fills the pores of the concrete and decreases its permeability.

The best proportions are: alum 1 part and hard soap 2 parts, both by weight. Soap varies in its chemical composition, and hence a single proportion can not be stated which will be chemically exact for all cases. The above proportion is in round number the relative combining weights of alum and average hard soap; and hence it is the best proportion to use, although widely different proportions have been used in practice with success. Any reasonably pure soap will do; but

if soft soap is employed, a greater amount should be used in proportion to the amount of water in it.

It is difficult to dissolve more than about 3% of hard soap in cold water; and hence this practically limits the amount of alum to 1.5% and of soap 3%. These amounts will give a precipitate equal to about 3% of the weight of the total water. The amount of precipitate formed in the pores of the mortar or concrete will depend upon the amount of water used in the mixing. Of course, if it were desired to use a greater quantity of soap and alum, the soap could be first dissolved in a similar quantity of hot water, which is afterwards mixed with the water used in making the mortar; but this is hardly practicable, nor necessary, as will appear presently.

An excess of alum does no harm, since alum alone is a fair waterproofing material. An excess of soap does no harm; and an excess is better than a deficiency, since the excess will unite with the free lime of the cement and form calcium soap—a finely-divided, water-repelling compound which is apparently the essential element of several of the proprietary waterproofing compounds. The above is the explanation why such diverse proportions of alum and soap give reasonably successful results in actual practice.

Effect of Water-Repelling Compound.

A film of oil on the wires of a moderately fine sieve makes it nearly, if not quite, water-tight. The question then naturally occurs: Can a water-repelling compound in the concrete act in the same way as oil on a sieve? Or in other words, can a volume of water-repelling compound less than the volume of the voids in the concrete decrease the permeability of the concrete in a greater ratio than the per cent of the voids filled? If so, then a water-repelling compound is more efficient in decreasing the permeability of a concrete than mere void-filling material.

To test the effect of a water-repelling ingredient upon the permeability of concrete, a series of experiments were made under the writer's direction by Mr. B. L. Bowling in the Cement Laboratory of the University of Illinois. The experiments consisted in molding a series of portland cement mortar disks in short lengths of 6-in. pipe, subjecting these disks to water under pressure, and measuring the amount of percolation. For convenience in making the experiments, mortar was used instead of concrete. The mortar for the treated and the untreated disks was alike except for the alum and soap compound. However, the mortars containing the alum and the soap were invariably drier than those made without these ingredients; but this probably has no significance in this connection. An annulus, 1-in. wide, at the circumference of both the top and the bottom faces of the disk was coated with hot asphalt, and also covered with a rubber gasket against which a flat casting was pressed by bolts through an external flange; and consequently the flow was through a disk 4 ins. in diameter and 2 ins. thick. The percolating water was caught in a tin funnel, the top of which fitted closely against the lower casting and the neck of which passed through a perforated rubber stopper into a bottle. The water pressure varied from 40 to 45 lb. per sq. in. The data and the results of the experiment are given in a following table. Tests 1 and 2 were made together, as also tests 3 to 6, and 7 to 9. The intention was to have four tests in each series, but through one reason or another some of the tests were of doubtful value or were useless, and hence are not reported.

The mortar used in making the disks was 1:6, which is unusually lean and porous, but it was purposely made porous the better to test the effect of the alum and soap compound. Known weights of cement, sand,

and water were used, and the volume of the mortar produced was measured; and then knowing the specific gravity of the several ingredients, the density of the resulting mortar was computed by a process not necessary to explain here. The voids in each disk are stated in the table, and ranged between 23.4 and 24.0%. If the sand had not been well graded, the per cent of voids would have been considerably greater, and also the individual voids would have been larger. A 1:2:4 concrete made of well-graded sand and stone would have only about 13 to 15% of voids.

The amount of water used in making each of the several disks is stated in the table. Knowing the percentage of alum and soap in the water and the amount of water used in mixing, it is easy to compute the amount of the precipitate in the mortar. The amount of precipitate in each disk is given in the table.

The percolation for each of several successive 24-hour periods is given in the table. The results show that the alum and soap precipitate is quite effective in decreasing the percolation. In the first series of experiments, No. 1 and 2, the alum and soap compound equal to 1.2% of the cement, stopped a little over 76% of the percolation during the first 24 hours; and the corresponding results for the other series are 54 and 69%, respectively. The variation in

The most interesting feature of these experiments is that the alum and soap compound equal to an average of 1.2% of the cement in a mortar containing an average of 23.7% voids, stopped 65% of the percolation; or, in other words, adding water-repelling void-filling material equal to approximately 5% of the voids reduced the percolation to one third of that of the untreated mortar. One can hardly conceive that an equal amount of a non-repelling void-filling material would be equally effective. Apparently then the alum and soap compound in the concrete acts like oil on the wires of a sieve. The experiments are being continued to determine the effect of the alum and soap compound with less porous mortars.

The mixing of alum and soap in the concrete reduces its strength somewhat; but there are many situations in which strength is unimportant, or at least is less important than water-tightness. The effect of the alum and soap upon the strength of the mortar varies a little with the method of storing the test samples. For example, the mean of six neat portland cement briquettes mixed with 21% of water which contained $\frac{1}{2}\%$ of alum and $1\frac{1}{2}\%$ of new "Ivory" soap, when left in the molds 1 day and stored in a moist chamber for 6 days, had a strength of 87% of that of similar briquettes made with water alone; and when left in the molds one day and then stored 6 days in

TABLE SHOWING EFFECT OF ALUM AND SOAP ON PERMEABILITY OF CEMENT MORTAR.

Test No.	Water in per cent. of dry Mat.	Precipitate.		Percolation, in Grams per 24 Hours.													
		Per cent. of cement.	Per cent. of voids.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	10	0	23.4	945	155	94	61	51	34	30	26	18	14	14	12	12	2
2	10	1.2	23.6	224	37	21	12	10	6	5	4	2	2	2	2	2	2
3	12	0	23.9	1,113.0	342.3	195.0	166.6	132.7	120.4	98.0	73.5	61.4	55.5	52.8	44.9	....	....
4	12	0	23.9	1,061.2	330.6	178.4	145.0	123.2	107.7	66.3	49.8	41.1	37.6	36.3	30.6	....	....
		mean		1,087.1	336.4	186.7	155.8	127.9	114.0	82.1	61.6	51.2	46.5	44.5	37.7	....	....
5	12	1.4	24.0	497.8	206.8	122.3	76.7	64.2	58.2	36.0	25.0	21.0	19.5	17.0	15.0	....	....
6	12	1.4	24.0	517.0	222.2	132.2	87.7	72.1	65.1	39.4	26.1	21.7	19.5	16.9	16.2	....	....
		mean		507.4	214.5	127.2	82.2	68.1	61.6	37.7	25.5	21.3	19.5	16.9	15.6	....	....
7	12	0	23.9	1,101.1	324.0	150.9	108.4	84.8	79.2	56.6	59.1	48.9	35.5	31.0	29.2	47.3	21.5
8	12	2.8	24.0	339.5	221.2	114.8	75.2	54.4	50.4	33.3	33.7	28.0	20.2	17.3	16.0	25.5	11.0
9	12	2.8	24.0	333.8	213.4	113.6	74.9	52.2	47.6	31.5	32.0	25.4	18.0	16.3	14.3	22.3	10.2
		mean		336.6	217.3	114.2	75.0	53.3	49.0	32.4	32.8	26.7	19.1	16.8	15.1	23.9	10.6

the several series is surprisingly large, but it is certain that the experiments were carefully made; and the range in the results probably indicates the effect of undetected inequalities in the materials, the proportions, and the mixing.

Somewhat similar results were obtained for each of the successive 24-hour periods. The decrease in percolation through the treated and also through the untreated disks is due to two causes, viz: 1. The percolating water doubtless has in it some solid matter, which clogs the pores of the upper surface of the disk. However, the water employed was that in the city water mains and was reasonably free from solids. 2. The percolating water takes up the soluble portions of the mortar from the upper part of the disk and carries them to the lower part. It is universal experience that all masonry becomes more nearly water-tight after use. It is interesting to note that in this series of experiments the average percolation during the twelfth 24-hour period was only 2.6% of that during the first period.

water had 84%; and when twice as much alum and soap were used, the strength was 83 and 71% respectively.

ALPHA CEMENT COMPANY'S BOOK.

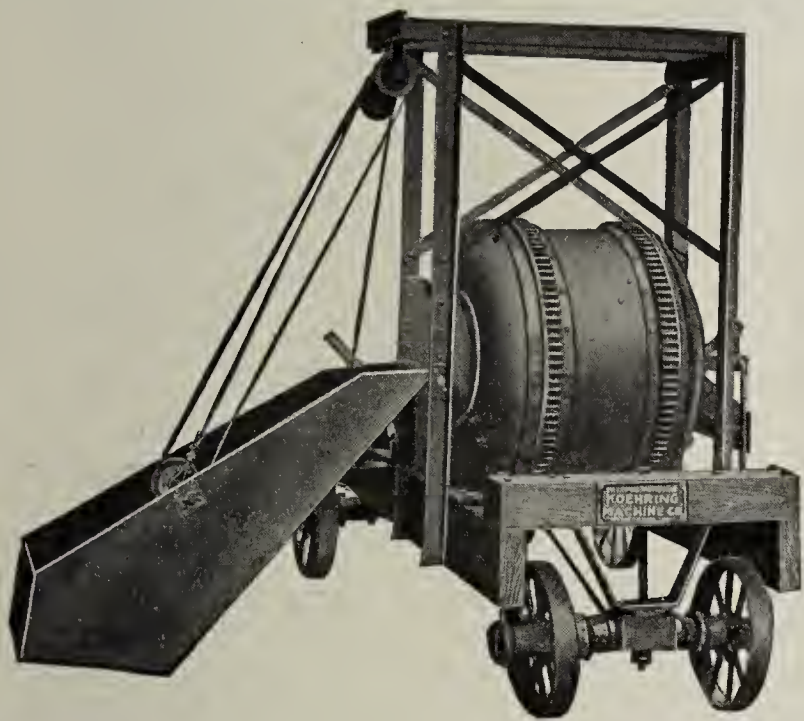
The Alpha Portland Cement Co., Easton, Pa., has published a large and elaborately illustrated book concerning the quality of the cement made at its mills at Martins Creek, Pa., Alpha, N. J., Cementon, N. Y., and Manheim, W. Va.; the methods of using it for many purposes requiring different methods of manipulation; and typical buildings, bridges, dams, retaining walls and other structures in which it was employed. The trade information relates mainly to aggregates, proportioning mixtures for various purposes, methods of mixing, the construction of forms, the prevention of injury to the work by frost, the construction of curbs and sidewalks, the treatment of concrete surfaces, waterproofing and the manufacture of concrete building blocks. Send for one.

A SUCCESSFUL CONCRETE MIXER.

There are so many concrete mixer patents granted these days that one who does not know the records of performance of the machines may easily go astray. The Koehring mixer is one which has demonstrated its adherence to the four cardinal points in a mixer, durability, simplicity, reliability and economy. A recent catalog shows many photographs of Koehring mixers on the work, and photographs of car loads of them on the way to Seattle and Los Angeles, showing that their good qualities are known very widely.

In their catalog is an illustration which shows mixer 1-B on trucks, equipped with elevating charging bucket and water measuring tank. This mixer has a capacity of 11 cubic feet of the materials, which are shoveled into the charging bucket, which is then tipped up by means of a hoisting drum. The batch, when mixed, is discharged on the opposite side by throwing the discharge chute into position. Discharge is stopped instantly by throwing the chute out of that position. The machine will turn out 14 cubic yards of mixed loose material per hour at a drum speed of 17 revolutions a minute, using a 6-horsepower steam engine or a 7-horsepower gasoline engine.

Another illustration shows the No. 0 street paving mixer with steam engine, boiler, elevating charging bucket and water measuring tank. This mixer has a capacity per batch of 9 cubic feet per hour or 14 cubic yards of loose materials, or 75 square yards of street, and will keep 17 men busy supplying material and



placing it in the street, including engineer and foreman. An attachment of boom and traveling bucket can be put on, which will deliver the material at any desired point of the street width within the reach of the boom.

The Koehring Machine Co., Milwaukee, Wis., will send on request a catalog showing the various styles and sizes of mixers and the attachments. The catalog describes in full the methods of construction of the machine and the reasons for its economy and durability. It also shows the various attachments, such as water measuring tank, a concrete hoist to be run by the same engine as the mixer, the hoisting drums and stone crusher, crushed stone elevator, and screen, an excavating loader, and wheelbarrows of their manufacture. Full instructions are also given for setting up and running the machinery.

R. How, of Medaryville, Ind., has invented a concrete tie which seems to be very satisfactory. The Chicago, Indiana & Southern R. R. have used some of them for the past year. Wm. Mulvain, section foreman at North Judson, Ind., says they are better now than when first laid. Also they do away with tie

plates, anti-creepers and anti-rail spreaders and are cheaper than wood and will last longer.

THE IOWA CEMENT CONVENTION.

The sixth annual convention of the Iowa Cement Users' Association was held last month in Cedar Rapids, with good crowds and ample exhibits to interest the visitors. An excellent program was provided, and everything was done to add to the interest of the gathering. The program was arranged to afford interest to all classes of cement users, and included a wide variety of topics.

After the opening preliminaries, J. E. Kirkham, of the Iowa highway commission, spoke upon reinforced concrete construction, giving the theory and practice of the best construction, along with a history of the development of reinforced concrete construction.

W. B. Wallace, of Cedar Rapids, gave his experience in handling concrete in freezing weather. While freezing before the initial set takes place, is destructive to concrete, he had found it possible to handle concrete in cold weather and prevent freezing until the first set had formed, without damage to the material. To do this, he had heated the materials used with live steam so that the concrete comes from the mixer hot, and is placed hot in the forms, retaining the heat long enough to allow the first set to occur.

Some discussion followed this address, and a number of different experiences in cold weather concrete work were given.

A topic of considerable interest was that of P. H. Atwood, of Armstrong, on cement drain tile. He stated that cement tile for drainage had made marked advance at the expense of clay tile, and attributed no small portion of the gain to the assaults which had been made upon the cement product. He urged that great care be taken in the production of cement tile, to see to it that there be sufficient water used, good cement, ample tamping, and a one to three mixture.

George P. Dieckmann, chemist for the Northwestern States Portland Cement Co., Mason City, addressed the convention on the method of manufacturing cement, illustrating his talk with lantern pictures showing views in the mill and the surroundings.

The Wednesday evening session was devoted to the formal welcome by city officials and responses on behalf of the association. President Carlon delivered his annual address, in which he outlined some of the hindrances which had been encountered during the past year, and the encouragements and the progress of the industry. He foresaw a greater future than ever, in the continuing development of further and greater uses for concrete in all directions.

An illustrated lecture by C. J. Blanchard of the government reclamation service, showed the use of cement in the development of irrigation systems under the government plans, afforded much interest and information upon the extent of the work in the West.

The Thursday session was devoted to a discussion of cement tile. Prof. A. Maston, of Ames, spoke on proper requirements, and gave the results of tests in such tile. He deplored the lack of a standard for such work.

The closing day was devoted to committee reports, and several addresses. G. E. Tatwell, of Cedar Rapids, told of steam curing, and F. M. Okey, of Ames College, of the permeability of concrete. President Humphrey of the National association, delivered an illustrated lecture.

The election of officers resulted in the following: President, L. L. Bingham, Estherville; first vice-president, C. C. Morillat, Winfield; second vice-president, A. A. Anderson, Lake City; secretary, J. A. Williams, Ames; treasurer, G. E. Tathwell, Cedar Rapids.

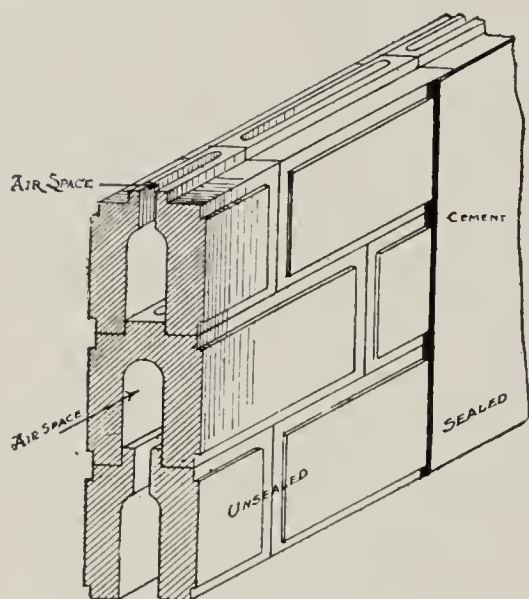
NEW MACHINE MAKES BLOCK OF UNUSUAL DESIGN.

A new type of block is herewith shown, together with the automatic machine on which it is made.

The block as made consists of two solid concrete walls or legs, each 4 inches in thickness, joined together by an arch, perforated in one or more places and as it is made on a pallet with a depression of from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in the central 4-inch space longitudinally, it produces a block similar to a piece of matched flooring—that is, with tongue and groove, the tongue being produced by this depression in the pallet, and the groove by the core between the two legs before mentioned. This groove is obtained by using a core which extends vertically five-eighths of the distance through the block.

The block as laid up in a wall, gives a complete horizontal circulation of air entirely around the building, and each horizontal air space in the block connects through the perforation in the arch of same with the air above and below; thus it will readily be seen that the air circulation is vertical as well as horizontal, and a wall built of these blocks would give a live air space—not a dead air space—both vertical and horizontal throughout the building.

This new one-piece block gives the same result in a wall that is obtained by two or three other very excellent two-piece blocks now on the market, some of which are held together by anchor rods, and others of which depend for their bond upon projections on the different pieces.



It is claimed for this block that it produces a wall that needs no furring or lathing, and is absolutely waterproof and fireproof, and because of the manner in which it is made, that a mixture of one part cement and five parts sand, gravel, limestone screenings, granite screenings or slag screenings, produces a block with sufficient compression strength, tensile strength and lateral bond to meet the requirements of any building ordinance.

The company putting this block on the market are also putting upon the market now for the first time an automatic machine which they claim will produce 1,000 of the above mentioned blocks, 24x12x9 inches, in ten hours. They claim for this machine that it will compress $1\frac{1}{2}$ cubic feet of loose material into 1 cubic foot of space and that their block as made up, containing 55 per cent of compressed concrete and 45 per cent air space of the above dimensions, can be made at an actual expense of labor and power of 2 cents per block.

The machine is entirely automatic except that the material must be fed into the mixer at one end, pallets inserted by the operator in the machine, and the blocks removed from the skid at the other end of the machine.

The machine as they construct it at the present time applies two independent compressions or "squeezes" of over 20 tons each to each and every block, and the automatic appliance for measuring material into the molds is such that the finished block does not vary three ounces in weight.

This machine is manufactured by the Western Shaw Block Co., 218 La Salle street, Chicago, and they have a machine in operation at the present time at Grand Crossing, Ill., that is geared to make one complete operation or block in thirty seconds. They claim that by increasing the strength and doubling their motive power, they could reduce the time in which a block could be turned off at least one-half. When it is understood that 1,000 building blocks of the dimensions above mentioned would construct a wall 100 feet long, 15 feet high and 1 foot thick, the marvelous capacity of this machine is apparent.

EXPORTS OF CEMENT TO LATIN AMERICA.

The following figures, compiled by The Dorrance Co., New York City, indicate the volume and the value of the exports of Portland cement from the United States to the following Latin countries for the years 1904, 1905, 1906, 1907 and 1908: Costa Rica, Guatemala, Honduras, Nicaragua, Panama, Salvador, Mexico, Cuba, Dutch West Indies, Santo Domingo, Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Portuguese West Indies, Philippine Islands, Canary Islands, Portuguese Africa and Spanish Africa.

1904.		1905.	
bbls.		bbls.	
110,445.....	\$ 204,332	325,645.....	\$ 508,417
1906.		1907.	
bbls.		bbls.	
377,067.....	\$ 609,765	605,798.....	\$1,050,981
1908.		Five Years.	
bbls.		bbls.	
747,298.....	\$1,196,985	2,160,253.....	\$3,570,480

THE CEMENT TRADE WITH FOREIGN COUNTRIES.

The imports of foreign cements into the United States have been dropping off at a very rapid rate in the past two years. In 1907 they were 2,111,819 barrels of 380 pounds, somewhat more than for a few previous years, but in 1908 they dropped to 883,418 barrels, and in 1909 to 454,510 barrels, the lowest figure in the published history of the industry.

The decrease in imports has been most pronounced in the trade with Great Britain, from which we imported only one-twentieth as much last year as in 1907; Belgium, which is reduced to one-fifth in the three years; Germany, reduced to one-fourth. The imports from France remain steadily about 40,000 barrels a year. The imports from Canada are fifty times as much as in 1907, now amounting to about 500,000 barrels a year.

The exports of cement seem to have increased from 900,550 barrels in 1907, and 846,785 in 1908, to 1,056,922 in 1909, but when the exports to Panama are deducted as being hardly foreign trade, the exports have really diminished about 200,000 barrels in the three years, for in 1907 Panama took only 82,569 barrels, and 75,666 in 1908, while the consumption on the canal in 1909 jumped to 438,876 barrels, as shown by the custom house records. Three-fourths of the last named amount was imported in the last six months of the year.

QUARTZ SILICA IN PORTLAND CEMENT MIXTURE.

By C. H. Sonntag

It has been known for a number of years that a raw mixture low in silica and high in alumina would give certain undesirable properties to Portland cement made from it. This fact, while well known to chemists and others intimately associated with the industry, is either unknown or disregarded by many of those who have to do with the organization and location of new cement projects. As a result, more than one plant has had trouble in starting up, and their chemists have been blamed for their inability to make a first-class product from materials that would have been condemned on the strength of their analysis alone by one competent to judge them.

Various investigators have shown that the silicates in Portland cement give it the properties of soundness and gradual increase of strength with age, while its qualities of quick hardening and early strength are largely due to the aluminates. A certain amount of alumina is desirable, even essential, in the manufacture of cement as we know it at present, but when occurring in excess it causes a tendency to quick setting which cannot always be controlled by the use of gypsum. It also lessens the allowable variation of the percentage of calcium carbonte in the raw mixture, so as to avoid quick-setting cement on the one hand, and unsound cement on the other.

The relative amounts of silica and alumina that are present in any given material are best expressed by the ratio of their percentages, for it is not their absolute percentages, but their relative amounts which are of importance in determining the availability of a raw material for cement manufacture. Some chemists consider the ratio of silica to the sum of the alumina and iron oxide, but the writer prefers not to consider the ferric oxide, as it has never been shown that its presence in reasonable amounts is deleterious.

The limits for this ratio are commonly taken as 3:1 and 4:1. Cements are on the market, however, having ratios both above and below these limits. The lowest known to the writer was in a sample of German cement, the ratio being 2.42:1. The highest was in a wellknown domestic cement, the ratio being 4.2:1. The German cement was probably burned in a vertical kiln, as the analysis is ten years old. It is questionable whether material having this ratio could be made into marketable cement by the rotary kiln process. As a rule, cements, having this ratio high are more easily manufactured, and have a better reputation for gaining strength with age, than those having a low ratio.

High relative silica being a desirable thing, it is important to secure this condition if possible. This is, of course, a simple matter if a clay or shale containing much free silica in a very fine state of division, or possibly in the colloidal state, is available. Certain glacial clays of northern Ohio and Indiana and southern Michigan are of this character. The loess of the Missouri valley in the region of Kansas City is also of this nature. Samples of this have shown a silica-alumina ratio of over 5:1, and all but 2% of this material passed a 200 mesh sieve. The writer has used it successfully as a source of silica.

Where such favorable materials are not at hand, however, the case is different, and it becomes necessary at times to go contrary to established practice to attain our ends.

There has always been a well-defined opinion among cement chemists that granular silica in the form of quartz coarser than 200 mesh must not exist to any great extent in shale or clay for cement manufacture, as it has been considered commercially impossible to grind it fine enough to secure complete combination with the lime in the burning process. This is particularly true in plants using soft marl, as the raw grinding machinery in such cases is not much more than an efficient mixing system on a large scale, and is entirely unfit to cope with such a hard substance as quartz in any quantity. In the laboratory, where any required amount of time may be taken for grinding, this objection does not hold, and the writer, as well as others, has made cement on a small scale with quartz as one of the ingredients of the raw mix.

It was the writer's privilege some time ago to start up a new mill as chemist, where this question of the use of granular quartz was brought forcibly to the front. To begin with, the office and laboratory building was not completed in time to permit any analytical work to be done, there being barely time to set up the apparatus for volumetric determination of lime in the mixture. The quarry consisted of about 18 inches of dark red clayey soil, the residue of the decomposition of the limestone beneath it, 16 feet of quite pure limestone, about 30 inches of hard blue argillaceous sandstone and an undetermined depth of hard blue shale. In passing, it may be remarked that occasional crystals of sphalerite occurred in both sandstone and shale, and films of galena were found in crevices in the limestone above.

The limestone was loaded into cars by hand, but the shale was loaded by a steam-shovel. As the writer and others at the plant were imbued with the idea that the sandstone could not be successfully used, it was thrown out. The mill started off nicely, grinding the raw material to a fineness of 97% through the No. 100 sieve, and 88% through the No. 200. The clinker had an excellent appearance, but the cement would not stand the boiling test. The percentage of lime was purposely varied within wide limits, but it was found impossible to make sound cement.

This went on for about three weeks, and in this time the laboratory was completed and analyses of the raw material and cement were made. The results are shown in the table, the analyses being carried only far enough to get the information desired.

- No. 1. Surface soil above limestone.
- No. 2. Limestone.
- No. 3. Sandstone.
- No. 4. Shale.
- No. 5. Cement when no sandstone was used.

	No. 1	No. 2	No. 3	No. 4	No. 5
Total insoluble		2.34			
Silica	60.12		77.90	61.86	21.70
Alumina	16.46		10.47	19.83	7.53
Ferric oxide	7.40	1.96	3.91	4.89	4.65
Lime	2.17	52.84	2.28	1.34	63.12
Magnesia	1.02	.61	.65	1.39	1.04
Sulphuric anhydride					1.32
Ratio Silica					
Alumina	3.65		7.44	3.12	2.8

Evidently the surface soil was of correct composition for use as a clay, but there was not enough of it, and it was of such a consistency, especially in wet weather, as to make its use almost impossible, so that it was not attempted more than could be avoided. It is to be regretted that the insoluble matter in the limestone was not analyzed separately, as it was not pure silica, and a complete analysis would doubtless show that the silica-alumina ratio of the limestone was

very low, thus bringing this ratio in the finished cement lower than in the shale.

This series of analyses showed the trouble to be the excessive proportion of alumina to silica. In this dilemma attention was turned to the sandstone that was being thrown out, as it was the only available source of silica. Inspection in the gross showed the sand granules to be rather coarse, and also showed the presence of numerous flakes of colorless mica. Examination with the microscope showed the sand grains to be true colorless quartz ranging in size from 0.15mm. in diameter to dust, there being a large proportion of the larger sizes. The mica flakes showed colorless, with traces of apparent hexagonal structure. In polarized light they gave only a gray interference color, showing their extreme thinness, and in convergent light showed the biaxial hyperbolas but no colors. Their usual range in size was from 0.25 to 0.5mm. in diameter.

The rock was so hard that it could not be disintegrated without crushing the quartz grains, so that a sieve analysis could not be made. But the size of opening of a standard 100 mesh sieve is 0.1397mm. (Tyler catalogue), so that it was evident that a large proportion of the grains were of about 100 mesh size, and many of them larger.

The steam-shovel operator was directed to dig in the proportion of one-fourth sandstone and three-fourths shale, as nearly as could be done. The results were extremely gratifying. As soon as this mixture got through the mill the cement became sound fresh from the mills, and no trouble was had thereafter from that source. Later, in an attempt to make softer clinker so as to favor an unsatisfactory finishing mill, the mixture was changed to one part sandstone and three parts shale, and this seemed to work as well as the 1:4 mixture. The following is a typical analysis of the cement shortly after starting the use of sandstone.

Silica	23.90
Alumina	6.47
Ferric oxide	3.99
Lime	62.60
Magnesia	1.30
Sulphuric anhyd.	1.19
Ratio Silica	3.7

Alumina

For some time the fineness of the raw material was held at 97% through the No. 100 sieve, this giving with the type of grinding machinery employed 88% through the No. 200 sieve. Later this was dropped to 95% through No. 100 and about 84 through No. 200 sieve, and this was found to be entirely satisfactory.

It might be supposed that the residues on the sieves would consist almost entirely of quartz. That this was not the case was shown by saving the sieve residues for several days and treating them with hydrochloric acid to dissolve out everything but sand and any coarse shale. It was found that the insoluble matter on the No. 100 sieve contained only 0.15%, and on the No. 200 sieve 1% of the original mix.

The writer has heard of other chemists who have had difficulty because of high alumina, and this article is written to show one way that this trouble was remedied, though in a way that has not in the past been considered strictly orthodox.

* * *

The Gates Reinforced Concrete Railroad Tile Co., of Tucson, Ariz., is the name of a new company recently incorporated by Frank Ross and George Gates.

SAILS FOR PHILLIPINE ISLANDS.

Harvey J. Hill, 7331 Stewart avenue, Chicago, formerly with the American Bureau of Inspection of Tests and later with the German-American Portland Cement Works passed highest in an examination held March 16th for cement inspector, Bureau of Supplies, Phillipine Islands.

Mr. Hill will be the Government Cement Expert at Manila. He is a young man of great abilities who will certainly be admirably suited for this position. We wish him success.

CONCRETE STREET PAVEMENT.

A concrete street pavement in Richmond, Ind., laid in 1896, is still giving good service and has not required a cent for repairs, according to Mr. Frank R. Charles, city engineer. Extreme care, he says, was taken in laying it. The sub-grade is gravel, the slab a 1:2:5 mixture, 5 in. thick after ramming, and the wearing surface a 1:2 mortar 1½ in. thick. The surface is cut into 5-ft. squares, and pitted with a roller. One-inch expansion joints are used at intervals of 30 to 40 ft., and are filled with paving pitch. The chief trouble has been due to spalling at the joints, especially along the longitudinal ones. In later pavements cutting into larger blocks has been tried in order to reduce the number of joints, but the maximum size is limited by necessary allowance of joints for temperature changes. Mr. Charles believes 15 ft. squares are as large as can be used with safety in a climate like that of Richmond. In some pavements laid more recently on streets carrying heavy traffic, the slab has been increased to 6 in. in thickness and the wearing coat to 2 in.

NEW COMPANY AT WATERLOO.

The Cement Products Company, of Waterloo, Iowa, has been organized in this city for the purpose of manufacturing concrete drain tile and other concrete products. The officers of the company are H. S. Raymond, president; H. A. Sharp, vice-president; E. E. Schenk, secretary, and W. H. Stewart, treasurer.

It is the intention of the company to manufacture anything in the line of concrete, besides doing a general dredging and general contracting business. The company is incorporated for \$20,000. They propose to install a plant in which the Schenk cement drain tile machine and the S. & S. equipment, manufactured by the Cement Tile Machinery Company, of Waterloo, Iowa, will be used. This is to be a model plant, using the steam curing system. They will also educate and instruct men how to operate the machinery and the S. & S. equipment, as they intend to co-operate with the Cement Tile Machinery Company. The plant will be used for demonstrating purposes and figures on costs of operation, etc., will always be open to the visitors so they will see exactly what the cost of production, as well as the profit, is in the cement drain tile business. It will also enable concerns starting up to secure competent men, as they will be trained in the operation of this machinery.

The plant is to be located on the river and they will reclaim sand. It will be pumped into settling bins and from there elevated into the plant, where it will pass through the sand screen and be graded into the sand bins. The plant will be in operation about May 1.

EXPERT TELLS OF CEMENT.

In Interesting Paper Edward D. Boyer Speaks of Wonderful Development of Material.

Before the meeting of the American Society of Agricultural Engineers, held at Ames, Iowa, recently, Mr. Edward D. Boyer, cement expert of the Atlas Portland Cement Company, read the following interesting paper:

Ten years ago if I had been asked to prepare a paper on Portland cement I would not have hesitated in supplementing my remarks on the subject by an elaborate description of the method of manufacture, its composition and general character; it is not more than ten years ago when we who were then engaged in its manufacture were frequently asked whether the name "Portland" indicated the fact that it had first been made or "discovered" in Portland, Me. I venture to say that to-day there are comparatively few people including farmers (which latter class were at the same period supposed to know very little of anything but farming) that do not know that Portland cement derived its name from a natural rock found in England that was supposed to be the hardest of known rocks; that the materials from which it is manufactured are clay and limestone, and which are found in nearly every State in the Union; that these two materials are chemically combined and proportioned, intimately mixed and finely ground and then burned into clinker under a high heat, and the grinding of this resultant clinker produces the Portland cement of which I speak to-day.

Ten years ago only about three and one-half million barrels were produced in the entire country, while the production for the year 1909 approximates sixty million barrels, and this phenomenal increase in production and consequent consumption reduced the price to such an extent that it was available in every community as a cheap building material. This, followed by extensive and judicious advertising, brought Portland cement before the notice of everyone contemplating building of any character from the twenty-story sky scraper in the large city to the chicken coop or hog pen on the farm.

And to this same farmer the material appealed most emphatically. He soon learned of its plastic character and his ability to mold it into any form. He read, he experimented and he asked questions, and I say to you to-day that the farmer with the use of his few barrels here and there was a great factor in keeping the mills running last year. There were some failures, but not as attributed to it by its competition, the clay tile, the brick and stone people, to the inferior quality of the material, but always to a lack of understanding in manipulation. I believe I am to-day in a State that is a great consumer of drain tile, and if I remember correctly it was in this very neighborhood that serious attacks were made on drain tile manufactured of Portland cement. How soon and how readily this attack was traced to the agents of the clay tile interests and how soon and how readily it proved a boomerang to them! There are miles of this cement tile in successful use throughout the Western country and I venture to predict that this tile will remain in the ground unattacked by the alkali bugaboo and without deteriorating or disintegrating long after the farmer who placed it there has passed away.

Plenty of Water Needed.

That there are failures in concrete and that this wonderful building material can be abused I will not

dispute, and one of the greatest evidences of this can be seen in the many unsatisfactory concrete block houses that have been built in the past five years. All these failures can be traced to the lack of knowledge of the material that entered into their composition. How many of these blocks were made throughout the country with not enough cement in the mixture to hold the sand grains together, and, most important of all, not enough water to even start the hardening of the cement! And right here I wish to emphasize this question of the use of water in making concrete. I would also say you cannot use too much water in mixing your concrete. Of course, you can drown your cement by the too free use of it, but as long as you can confine the water to the mass, that is, not allow it to flow off your mixing board, carrying the cement with it, it is far better than to have your mass so dry that it hardly sticks together even with vigorous tamping. The concrete block industry has passed through all the stages that usually develop in a new material and with mistakes in manufacture and exploit has still survived and is bound to become one of the leading building industries of the country.

It appeals to the man of industry and thrift; to the farmer first, because if he is the least ambitious he can mould the block himself, a few at a time in his leisure moments, knowing that after being cured they can be stored in any old place, even out in the weather, until he finally has enough to lay up the foundation and walls of his own home, a building that will last for all time, will require no paint, no repair, will be cool in summer, and warm in winter, and a home to be proud of and enjoy.

Much has been written and said on the subject of concrete blocks, and I would not hesitate to occupy time on the subject if I did not know that even to-day there are inferior blocks being manufactured. It is hardly two months ago that I was called to a village not 1000 miles from New York on a complaint of poor quality of cement. On the front of the "factory" was this sign, "Manufacturer of Waterproof Concrete Blocks." Blocks were being manufactured when I arrived. The mixture was probably correct, one to five for the base and 1:1 for the face of the block, but water was the scarcest article on the premises. The mixture was hardly wet enough to ball when pressed in the hand, and I was informed that the blocks were molded in this manner and allowed to stand until the next day, when they were plentifully sprinkled. On what were supposed to be cured blocks I poured a scoop shovel full of water that disappeared so rapidly in the block that the surface was dry a few minutes after and all because to use more water would have reduced the quantity of block that could be made in a given time, thus increasing their cost! Will it be surprising that the man for whom this house is being built will in a short time complain of dampness in the interior, paper coming loose from the walls, etc., and that he will tell his neighbor who contemplates building not to use cement, it is no good? I believe you of the West interested in block manufacture have learned this lesson and arrived at the stage where you know it is not so much the particular machine, nor yet the particular brand of cement, as it is that the aggregates, the sand, must be of good quality, free from loam and vegetable matter, properly graded and the mixture sufficiently rich in Portland cement, and all mixed with enough water to properly assist in hardening.

Best Means of Waterproofing.

And on the subject of waterproofing a block or anything else made of cement concrete I believe a richer

mixture, that is, the use of more cement, will be more effective, durable and lasting than the use of any of the many so-called waterproofing compounds at present on the market. I feel sure that a rich mixture with the additional use of 10 per cent of hydrated lime, that is, 10 pounds of properly hydrated lime to every 100 pounds of cement used, will most effectually waterproof concrete and prove considerably cheaper than the use of the waterproof compounds referred to.

The fact that sand and gravel are found all over the country and on most every farm, or at least in such close proximity that teaming to the work is the only cost, has made concrete the ideal cheap building material, and of this sand I wish to say again that first of all it must be clean. However, the fact that the sand you wish to use is not clean does not prevent its use. Water is also cheap and plentiful in this glorious country of ours, and to wash thoroughly and flood your sand with it is no difficult job, nor does it cost anything. Loam, vegetable matter, clay and most impurities can be removed in this way. Of course, your sand must be hard; a shaley sand is no good. Always remember that a concrete is no harder than the aggregates of which it is composed, and, therefore, avoid the use of shales of any character, of brickbats, and of soft sandstones. Sand, too, should be well graded from coarse to fine. Remember that a theoretically perfect concrete has every grain of the aggregate covered with cement so that the hardening of the material can occur uniformly and effectively. Every void is supposed to be filled, the smaller grains fitting into the larger, and the nearer your concrete reaches this condition the better it will be. You can use all fine sand—yes, but you will readily understand that it will require more cement and therefore cost more money. And again, you can understand how much more carefully the materials must be mixed to accomplish the required result of having each particle of the aggregate covered with the cement if you use a fine sand than if you use a well-graded one.

This subject of mixing is also important. The mixing of the sand and cement, then the addition of the crushed stone or gravel, and finally the water, all tossed about on the board or in the box until you have one homogenous mass, must be carefully conducted. Tools for the work are always on the farm and one of the best is the ordinary garden rake.

Uses of Concrete on the Farm.

The uses of concrete about the farm are so many and so varied that I can hardly do more than touch upon them separately. To the farmer whose property has been run down, whose board walks are rotten and whose doorsteps are rickety, whose fences are half down and many of the posts rotted and useless, whose cistern leaks and floor is decayed, whose silo is not air or frost tight, whose hog troughs have been chewed by the hogs until they scarcely hold the mash, whose horse mangers are in the same condition and stalls kicked to splinters, whose water troughs leak water faster than it can be pumped in, whose chicken nests are filled with vermin, and finally whose barns have become weatherbeaten and are falling into decay, this material emphatically appeals.

I am frequently asked whether frost will affect concrete, and again this point appeals to the farmer, from the fact that the winter months are his idle months, with time to devote to the making of fence posts, for instance, and is therefore important that he should know that frost does affect concrete, but only before it has set. If there is any way to protect concrete after being placed, for a few days or till after it

has hard set, there is absolutely no danger. And here again the farmer has the best protector for concrete and it is right in his manure yard. The covering of manure over concrete will thoroughly protect it from frost. Care must be taken that the aggregates are free from ice particles, the water, if possible, and the aggregates heated to about eighty degrees Fahr. and the concrete promptly placed and covered as above. A point I wish to make right here is that only a sufficient quantity of mortar should be mixed at a time as can be used at once, as a mortar that has become set or even partially set is absolutely worthless and should be discarded. Fence posts can be molded in a warm building a few at a time during the leisure moments, and after a week can be placed in the open without fear of disintegration and it will be surprising when the spring comes how many of the rotten field posts can be replaced and how soon the entire farm can be surrounded by a fence that will always remain erect and that will never acquire renewal. What, really, does first cost mean or amount to in the mind of the progressive, up-to-date farmer when this boon is in sight?

Fireproof and Sanitary Qualities.

And best of all, and what I have not before mentioned, are the fireproof qualities of this material. Again this should especially appeal to the farmer whose isolated location usually leaves him without fire-fighting apparatus. Concrete is fireproof, absolutely, as was proven in the great San Francisco earthquake and fire, where concrete was the only building material that in any way withstood the ravages of the flames. There are also several instances where fires in houses throughout the country gutted the house, even to burning out the window sash and frame, but the concrete remained intact and as good as before the fire.

Concrete is also sanitary in every sense, and healthful conditions exist wherever it is being used in buildings. Buildings of concrete can be flushed out with water regularly without damage to the material. Moth nor rust will not corrupt, nor can thieves break in or steal. I have a friend who says he wouldn't have a concrete house because you couldn't tear it down nor even burn it down, and the only way to remove it would be to blow it away with dynamite.

CEMENT PRODUCTION IN 1909.

Preliminary Estimate by the Geological Survey.

The following preliminary estimate of the production of cements in the United States in the year 1909 has been prepared by Ernest F. Burchard, of the United States Geological Survey. The annual statistics of the mineral production of the United States are ordinarily collected by the Geological Survey only, but those for 1909 are being collected by the Survey in cooperation with the Bureau of the Census, in order to avoid annoyance to miners, manufacturers, and others by duplicate requests from government bureaus. This cooperative arrangement will necessarily result in considerable delay in the publication of the report on the cement industry for 1909 and for that reason many manufacturers requested the Survey to collect the data on cement in the usual manner. The Director of the Census approved the course requested, and accordingly the usual inquiries were sent by the Survey to cement producers. Owing to the conditions stated, these requests were sent out more than two months later than last year, but replies have

now been received from about 88 per cent of the Portland cement companies in the United States.

As shown by the quantities reported in the replies received, to which has been added the estimated output of the small number of producers who have not yet responded, the production of Portland cement in 1909 was between 61,300,000 barrels and 62,000,000 barrels, which valued at 85 cents a barrel, was worth at the mills between \$52,105,000 and \$52,700,000. This represents an increase in quantity of at least 10,227,000 barrels and in value of at least \$8,557,000 over the production in 1908, which amounted to 51,072,612 barrels, valued at \$43,547,679. The increase in quantity was therefore at least 20 per cent over that of 1908. The reported selling price per barrel averaged the same as in 1908—about 85 cents—although Portland cement was sold during the summer of 1909 at a figure so low as to cause a general expectation that the average price for the year would fall below that of 1908.

The returns for the production of natural cement are not yet quite so complete as those for Portland cement, but they indicate that the total production in 1909 was not far from 1,500,000 barrels, valued at about \$675,000, an average value of 45 cents a barrel. These figures show a slight decrease as compared with those for 1908, when the production was 1,686,000 barrels, valued at \$834,509.

The production of puzzolan cement, as reported, shows a slight increase, about 160,646 barrels, valued at \$99,452, having been produced in 1909, as compared with 151,451 barrels, valued at \$95,468, in 1908.

The details of manufacturing developments and trade conditions will be discussed in the annual report of the Survey on the cement industry, which is now in preparation as a chapter of the volume on "Mineral resources of the United States, calendar year 1909."

BUSINESS NOTES.

The Kansas City Material Company has been organized with a capital stock of \$50,000 and the following officers: President, W. H. Caffery, Kansas City; vice-president, Joseph Freund, St. Louis; secretary and treasurer, H. F. Herman, St. Louis. The new concern will manufacture and handle building material, crushed rock, cement, etc., and a large rock crushing plant is now being erected four miles east of Independence, Mo., on the line of the C. & A. railway.

* * *

Mr. W. S. Osborne, formerly connected with the B. F. Sturtevant Company, of Hyde Park, Mass., and the inventor of the Osborne system of pneumatic collecting and separating apparatus, has recently associated himself with the Griscom-Spencer Company, 90 West Street, New York. All forms of Osborne pneumatic apparatus, including the separating and grading machinery for handling powdered materials, apparatus for hydrating lime, and pneumatic apparatus for desiccating liquids containing solid residues of any kind, will hereafter be manufactured by the Griscom-Spencer Company. A new catalogue, known as No. 109, has been recently issued, briefly describing the various types of apparatus of the Osborne systems, and will be sent to any inquirer.

* * *

The Atlanta, Ga., firm of Solomon & Norcross, civil engineers, have been awarded a contract by the city council of Troy, N. Y., to build a diversion dam and sewer, at a cost of \$225,000. The firm of Solomon & Norcross is composed of Mr. Gabriel Solomon, formerly of Macon, Ga., and a graduate of the Rensselaer Polytechnic Institute in Troy, and Mr. Paul Norcross, born and reared in Atlanta and educated at the Georgia Tech.

ROOSEVELT DAM.

Roosevelt dam, the great engineering work, designed as part of the Salt river irrigation project in Arizona, is nearly finished. At 4 o'clock (April 20th) the United States closed down its cement plant at Roosevelt.

The reservoir created by the dam is the largest artificial body of water in the world. Its capacity is 61,000,000,000 cubic feet. If its waters were spread over Delaware, it would cover the entire state a foot in depth. The dam is 280 feet high, 180 feet long on top, and contains 326,000 cubic yards of masonry.

It is expected the dam will be completed in June, but the project will not be formally opened until fall. A movement has gained headway in Arizona to have former President Roosevelt open the project on his birthday, October 27.

The government began the manufacture of cement for the Roosevelt dam nearly five years ago because of its inability to obtain cement at reasonable prices, owing to the inaccessibility of the site. The engineers of the reclamation service say that the mill saved the government more than \$650,000.

The plant turned out 320,000 barrels of high-grade cement, most of which was furnished to the contractor who is building the dam.

When completed the project will cost \$8,649,000. It will irrigate 240,000 acres of land.

WM. B. HOUGH CO'S NORTHWESTERN OFFICE.

The William B. Hough Company, whose main office is in Chicago, has found the Northwest such an attractive field for the sale of concrete mixers, hoisting engines, reinforcing steel, etc., that it has just established a branch office there. This Northwestern office will be located at 902 Lumber Exchange, one of the most convenient and active centers in Minneapolis. The Northwestern office is qualified to advise with customers as to the machinery and equipment best adapted to handle any proposed construction quickly, efficiently and economically. It is also competent to give expert assistance in solving problems concerning the reinforcement of concrete in order to insure safety and accomplish economy of design. In fact, this office was established with the intention of so equipping it as to give absolute assurance of the same high order of intelligent, reliable service for which the home office is known.

CHANNON'S NEW CATALOGUE.

One of the most elaborate books ever published for the convenience of contractors is the 952-page volume known as Catalogue 50 of the H. Channon Company, Market and Randolph Streets, Chicago. The company is agent for many of the leading manufacturers of construction specialties and also makes a large line of its own, so that it is able to make deliveries of complete equipments for most contracts. This book is intended to give the prospective purchaser enough information regarding different types of supplies and equipment for the same kind of work to allow him to make selections answering special conditions or meeting individual tastes. Consequently the volume is a kind of encyclopedia, which is fortunately supplied with a comprehensive index which makes it possible to use the bulky work readily. This book should be in the hands of every contractor, builder, cement manufacturer, sand, lime, crushed stone and plaster manufacturer in the country. Just mention Cement and Engineering News when writing for it and they will gladly send one to you, gratis.

CEMENT MILL NEWS.

By a premature explosion in the stone quarry of the Nazareth Portland Cement company, Nazareth, Pa., eleven men were buried under 5,000 tons of rocks and killed, and one other was injured so seriously that he can not recover.

All the victims are Hungarians and Italians and were known about the quarry only by number.

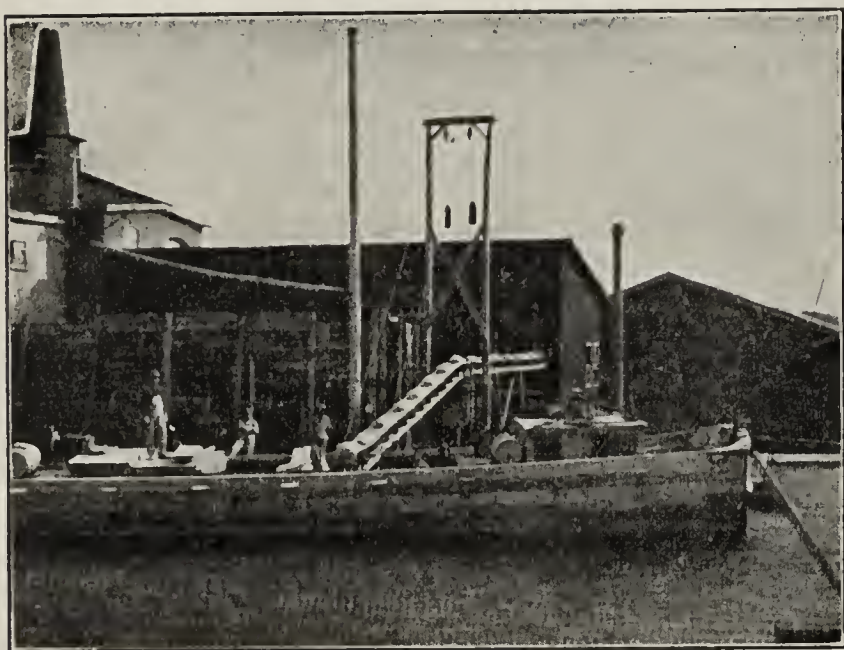
The quarry force were preparing to put off a blast in four holes each twenty-four feet deep, when, from some unknown cause the charges were exploded. The entire side of the mountain of rock was torn loose and the unfortunate laborers were covered with earth and stone.

The roar of the explosion was notice to the people of Nazareth and the surrounding country that an accident had happened and a large crowd flocked to the quarry.

* * *

The Bronson (Mich.) plant of the Chanute Cement & Clay Produce company is to be sold in bankruptcy court. Whether it will be offered at public or private sale and the time of the sale will be decided by the referee in bankruptcy, H. L. Snyder.

The plant is appraised at \$75,000. It is encumbered by a first mortgage bond issue of \$100,000, and by also the Chanute bond issue. Judge H. H. Barlow of



We wish to make a correction of a statement which appeared in our last issue concerning the above illustration which shows a Robins Belt Conveyor in use to facilitate the unloading of cement at the piers and which we erroneously stated last month to have been installed at the Alsen Cement Plant. The conveyor shown however was located in a different part of the country.

Bronson, Mich., will attend the hearing on the question of the sale. He represents the first mortgage bondholders and attorneys were also here representing the Cleveland Trust company, trustees of the Chanute bond issue.

* * *

The Coplay Cement Manufacturing company met at the plant at Coplay, Pa., early in the month and elected the following directors: Ralph Blum, Arthur K. Kuhn, Joseph L. Berg, Gabriel Bluf, William H. Harding, Samuel Y. Heebner, Penrose Fleisher, Frank H. Bachman, Ferdinand L. Loeb, Abraham Israel, Frederick J. Geiger, Charles M. Saeger and C. H. Moyer.

* * *

The securities of the Canada Cement company have been listed on the Montreal stock exchange. Ex-

pectation here is that the first quarterly dividend of $1\frac{3}{4}$ per cent on Canada Cement preferred will be declared soon.

A proposition to increase the capital stock of the Whitehall Portland Cement company by issuing preferred stock to the extent of \$1,000,000 was rejected at a special meeting of the stockholders. The total capitalization of the company is \$500,000, represented by common stock. There is no preferred stock, but the company has outstanding bonds and loans amounting to \$900,000. Several months ago a number of the stockholders conceived the plan of creating \$1,000,000 of preferred stock, to be issued from time to time, the proceeds from the sale of stock to be used in retiring the bonds and loans and for purchasing new machinery. A disinclination on the part of the stockholders to subscribe to the proposed issue led to the proposition being voted down.

* * *

At a special master's sale at Chanute, Kan., April 14, a committee representing the bondholders in the Chanute Cement and Clay Products Company bid in the uncompleted plant, including a site of 160 acres and railroad switches, for \$77,200. The committee also bid in 366 acres of land in Wilson county for \$7,900, and gas leases for \$2,105, making a total for all property purchased of \$87,205. The bondholders plan to reorganize the company at as low a capitalization as possible. It will take three months to complete the plant.

* * *

At the annual meeting of the Wolverine Portland Cement company, Coldwater, Mich., held the last of March, officers were elected as follows:

L. M. Wing, president; F. M. Rudd, vice-president, and E. R. Root, secretary and treasurer. The following directors were also elected to serve the coming year: L. M. Wing, Coldwater; D. C. Rexford, Detroit; J. W. Helme, Adrian; Charles Briggs, Calumet; F. M. Rudd, Bronson; C. C. Jones, Quincy, and H. Bastianelli, Rochester, N. Y.

* * *

The Atlas Portland Cement company has about completed the construction of a fireproof concrete building for the manufacture of cotton cement bags. The capacity of this plant will be about 30,000 finished bags per day. All the latest and most improved machinery has been installed.

W. D. PHILLIPS RESIGNS.

W. D. Phillips, sales manager in charge of the New York office of the Bradley Pulverizer Co., resigned his position on May 1st, 1910. Mr. Phillips was very active in successfully introducing the new 40" Griffin mill in the cement industry and deserves credit for having sold these mills to the following cement companies:

Name	Location.	No. of 40" Griffin Mills.
American P. C. Co.,	Norfolk, Va.,	10
Knickerbocker P. C. Co.,	Hudson, N. Y.,	23
Security Cement & Lime Co.,	Security, Md.,	12
Clinchfield P. C. Co.,	Kingsford, Tenn.,	4
Standard P. C. Co.,	Leeds, Ala.,	1
Virginia P. C. Co.,	Fordwick, Va.,	4
Lehigh P. C. Co.,	Ormond, Pa.,	3
Oklahoma C. P. C. Co.,	Hartshorne, Okla.,	5
Great Western P. C. Co.,	Mildred, Kan.,	1

WATER SOFTENING AND PURIFYING SYSTEMS.

Boiler owners are realizing more and more the waste and expense due to impure feed water that scales and corrodes feed water heaters, piping and boilers, in addition to the enormous waste of fuel.

Wm. B. Scaife & Sons Co., of Pittsburgh, Pa., manufacturers of the Scaife and We-Fu-Go Water Softening and Purifying System, report an unusually large volume of business; among some of their recent orders for the Scaife and We-Fu-Go Systems are the following:

American Sheet & Tin Plate Company, Vandergrift, Pa., 15,000 H. P. We-Fu-Go System.

Auburn & Syracuse Elec. Railway Co., Auburn, N. Y., 750 H. P. We-Fu-Go System.

River Furnace & Dock Co., Cleveland, Ohio, 6,000 H. P. We-Fu-Go System.

Capac Paper Co., Capac, Mich., 600 H. P. We-Fu-Go System.

New York & New England Cement & Lime Co., Hudson, N. Y., 8,500 H. P. We-Fu-Go System.

Galena Smelting & Mfg. Co., Galena, Kansas, 150 H. P. Scaife Automatic System.

The Pocasset Worsted Co., Thornton, R. I., 1,000 H. P. We-Fu-Go System.

Spencer Kellogg & Sons, Buffalo, N. Y., 150 H. P. We-Fu-Go System.

Continental Fibre Co., Newark, Del., 250 H. P. Scaife Automatic System.

MIRACLE'S NEW BOOKLET.

"Miracle Concrete," Vol. 3, No. 1, published by the Miracle Pressed Stone Co., of Minneapolis, Minn., is just out and contains some very practical suggestions for 1910, and a straight-from-the-shoulder talk with block makers on the necessity for producing a wider range of block faces and conforming more closely to the idea of architects as to artistic design. Some of the latest Miracle specialties, such as collapsible culvert molds, ornamental molds, and positive-feed continuous mixer, are also described.

TRADE NOTES.

George Foster, Arnett, Oklahoma, was awarded the contract for a \$15,000 school building for the town of Jet, Okla. The hall floors, ceilings, stairways and partitions are to be of reinforced concrete.

* * *

The Lehigh Portland Cement Company, of Indianapolis, Ind., has recently issued a booklet covering the construction of the new filtration plant of the Louisville Water Company. This plant is the largest of its kind in the world and was designed by Charles Hermany, prior to his death, in January, 1908. Mr. Hermany was the chief engineer of the water company. Some time prior to his death Webster Gazlay had been employed as an associate engineer by the water company and since Mr. Hermany's death the design and construction has been under his direction, he taking up the work where the latter left off. The capacity of the plant when completed will be 14,046,700 gallons and in the construction of same 18,000 barrels of Lehigh Portland cement will be used.

* * *

Smith, Emery & Company, Inc., 651 Howard street, San Francisco, Cal., have just issued a handsome catalogue giving valuable information of their work on iron, steel and cement inspection. They have established a modern up-to-date inspection and testing establishment at above address.

NEW CEMENT PLANTS.

We are advised by Mr. A. S. Ford, Secretary of the Peoples Portland Cement Co., Great Northern Bldg., Chicago, that they have just let the contract for the kilns for their new plant at Sandusky, Ohio. The kilns will be 8x125 ft. Contracts are also being let for the grinding machinery, power plant and electric motors.

* * *

The Alpha Portland Cement Company, of Easton, Pa., is building a new cement plant at Alsens, N. Y., which will contain many interesting features and be a model plant. Electric drive will be used throughout the mill. Power for these motors will be supplied by producer gas engine generators. The contract for the entire equipment has been awarded to Allis-Chalmers Company. It will consist of three 24x36 in. single tandem gas engines, each direct connected to a 530 K. V. A., 480 volt, 60 cycle, 3 phase, 150 R. P. M. alternator. A motor generator set will supply direct current and belted exciters will furnish excitation current. A six panel switchboard of black marine finished marble will hold the controlling apparatus. The air compressor will be driven by vertical gas engine. Cooling water will be circulated by a motor driven pump. Gas for the engine will be supplied by producers.

* * *

Bethlehem, Pa.—The contract for a steel building, machinery and their installation for the Lily White Cement Company, of Nazareth, Pa., has been awarded to George S. Emerick, of Nazareth, who will commence work thereon immediately. The mill will have a daily capacity of 500 barrels. This company last year acquired by purchase a tract of about forty-six acres of land on the L. & N. E. R. R., at Heck's Crossing. The property is underlaid with an immense deposit adapted for the manufacture of white cement. There is now on the property a wellconstructed siding and a quarry.

* * *

Following the success which has attended the operations of the Cementos de Hidalgo, S. A., several of the wealthy men of the section around Torreon, Mex., are taking steps to organize a company with a capital of \$500,000 for the establishment of a cement plant.

At the head of the movement is Cristobal Martinez, and it is said that several substantial amounts have already been subscribed.

It is said that the material required in the making of cement has been found in large quantities near the city and the plant would not be far distant from Torreon if it is built.

* * *

Halifax, N. S.—A local report states that a representative of a large English cement manufacturing concern has been investigating the Maritime Provinces as a future field for establishing cement works, to be operated independently of the Canadian merger formed.

* * *

The incorporation is announced of the Dominion Cement Company, Limited, of Montreal. The capital stock is \$5,000,000.

* * *

The United States Gypsum Company began work April 1st at Fort Dodge, Iowa, on a new stucco mill to cost \$200,000 and to be the finest mill owned by the company and one of the finest in the world. It will be six kettle capacity and absolutely fireproof. The structure will be completed by September 1st.

A cement plant, costing in the neighborhood of \$1,000,000, with a capacity for producing 1500 barrels per day, will be constructed by the New England Portland Cement Company in Knox County, Maine, during the present year and placed in operation in season to supply the spring market of 1911.

* * *

Cuban-American Cement Co.: Corporation Trust Co. of America, Wilmington, Del., capital, \$100,000. Incorporators: Wm. R. Watson, John S. Stubbs, Arthur W. Britton, all of New York City.

* * *

At the annual meeting of the Wolverine Cement Company at Coldwater, Mich., the other day the directors—L. M. Wing, Harry Bastainella, J. W. Helme, Frank M. Rudd, Dwight C. Rexford and C. H. Jones—were re-elected. The stockholders resolved to authorize the directors to purchase the cement plant at Bronson, Mich., owned by the Chanute Cement & Clay Products Co. The Wolverine company already own a good share of the marl land near the Bronson mill. Frank M. Rudd, Henry P. Mowry, James S. Galloway, Clinton H. Powely and Albert M. Shepard will act as trustees. They will take the plan and property in the interest of the first mortgage bondholders. It will be called the New Bronson Portland Cement Company.

* * *

The Morgan Portland Cement Co., Allentown, Pa.,

is considering plans for the installation of machinery for a 2,000-bbl. plant and provision will also be made for a 2,000-Kw. power plant, the equipment of which has not yet been decided upon.

* * *

The Colonial Portland Cement Corporation, of Alexandria, Va., has been granted a charter by the state corporation commission, with a maximum capital stock of \$3,000,000 and a minimum of \$1,000. The objects are to manufacture and sell cement. Following is the list of officers: Wister M. Balderston, president; W. C. Balderston, secretary, both of Washington; Frederick P. Russell, treasurer, Alexandria. The state secured a fee of \$600 upon the issuance of the charter.

* * *

The Washington Portland Cement Company at Concrete, Wash., has already arranged to expend \$300,000 to enlarge its plant to a capacity of 2,000 barrels a day. The machinery has been ordered and the addition to the plant will be finished by November 1.

* * *

The plant of the Lake Shore Portland Cement Company at Sandusky, Ohio, which has been taken over by the People's Portland Cement Company, is now being pushed to completion and expects to be making cement sometime during the summer. Plans are also actively being made to go ahead with the construction of the company's plant at Spokane, Wash.



INSPECTION TRIP TO CEMENT MILLS AND STEEL PLANTS.

A delegation of officials of the city of Champaign, Ill., university professors of the University of Illinois and contractors of Champaign inspected the cement mill of the Universal Portland Cement Company at Buffington, Ind., and also the steel mills of the Illinois Steel Company at Gary, Ind., as guests of the Universal Portland Cement Company on April 20th.

Arriving at Buffington at one o'clock, the entire party, under the guidance of officials at the plant, was shown the process of manufacturing cement and preparing it for shipment in sacks. The process was explained in detail, which proved interesting and instructive to many of the guests, who were not familiar with the modern methods in use at this, one of the largest individual cement plants in the country. The day was pleasant, but very windy. More than an hour

was consumed in inspecting this great plant. When the party again boarded the special train the visitors were served with a luncheon prepared by one of Chicago's famous chefs, which assuaged the hunger produced by the arduous task of inspection amidst a cement dust laden atmosphere. Parched lips and dry throats were gratefully restored to their normal status by imported table waters and other popular beverages.

Arriving at Gary at three o'clock, the visitors took in all the interesting points of this new and wonderful steel manufacturing town. After this the party boarded a train of flat cars for movement through the steel mills. Inspection was made of the ore docks, ore unloaders, blast furnaces, power plant, open hearth furnaces and rail mill of the Illinois Steel Company. At five o'clock the visitors again boarded the special train for home, which arrived at Chicago at a little after six o'clock p. m. Bright skies and sunshine produced a perfect and ideal summer's day, making the trip a very enjoyable and interesting outing.

The company has a mill site of twenty acres near Spokane, with plenty of electrical power, and raw material to profitably manufacture cement at a low cost. Representatives of the concern have obtained options on several of the largest limestone deposits in the Pend Oreille valley, north of Spokane, also in other parts of the district, called the Inland Empire of the Pacific Northwest. They have offices at present in the Great Northern Building, Chicago, Ill.

* * *

Winnipeg, Man.—The Central Portland Cement Co., Ltd., has been incorporated by William Fox, Valdimar J. Melsted, of Minneapolis; Chas. Blake, Leonard Cashmore, and Henry F. Tench, of this city. The business offices are located here.

* * *

The Thomas Millen company, of Jamesville, N. Y., is planning to establish a cement making industry in connection with the lime kilns and quarries at Jamesville.

The company has negotiated with the Empire Portland Cement company, of Warners, N. Y., for considerable of its laboratory equipment. This will be moved to Jamesville and the new plant established at once. The laboratory will be in charge of an experienced cement chemist.

It was stated to-day that the new industry would be started in a small way and as somewhat of an experiment. But one kiln will be erected at first. If the venture proves successful, however, it is planned to add to the plant rapidly, and enter the cement market on a large scale.

The limestone found in the Millen quarries at Jamesville contains in proportionate quantities the properties necessary to make it a first-class cement. Another advantage which the Jamesville site for the new plant offers is the class proximity to the proposed new Solvay Process quarries, enabling the cement makers to secure a sufficient quantity of crushed stone with small trouble and expense.

The difference in freight rates from Jamesville to the important cement distributing points as compared with those from the cement district in Western Pennsylvania is another condition favoring the new industry.

It was announced to-day that big western cement manufacturers are negotiating for the purchase of the plant of the Empire Portland Cement company at Warner. If the deal goes through the new interests will operate the plant to capacity. If it fails to materialize there is another proposition to dismantle the property.

General Miller, of Franklin, Pa., is the owner of the Warner property. Harry S. Hayden is the manager.

* * *

Theodore Dickinson, vice-president of the Marquette Cement Manufacturing Company, La Salle, Ill., will retire from active business life after ten years connection with this company. He expects to devote his time to travel and recreation. It is understood, however, that Mr. Dickinson retains his control of the company, being the largest individual stockholder.

* * *

The Hercules Waterproof Cement Company has filed papers of incorporation in Buffalo. The company is capitalized at \$100,000. The directors are Charles F. Peters, J. Louis Seligman, Henry C. Hutchinson, Charles Kuhn and Philip A. Sullivan, all of this city.

THE MUNICIPAL CONTRACTORS.

The third annual convention of the Illinois Association of Municipal Contractors was held recently in Chicago.

This association is composed of about seventy-five municipal contractors, most of whom are located in the smaller towns of the state. The officers of the association have been very energetic in pushing both the work and the association and for the purpose of carrying on a campaign have established an office at 805 Atwood building, Chicago. The object of this association is:

To promote and encourage and facilitate the making of public improvements.

To secure a higher degree of accuracy in the legally prescribed procedure and proceedings.

To collectively bear the expense incident to the making of abstracts of legal proceedings and the examination thereof.

To stimulate the market and the demand for approved improvement bonds and protect the contractors against unwarranted exactions and unreasonable discounts.

To secure better specifications for public improvements, a greater uniformity in the specifications, and where practicable, a classification of the various branches of public work.

To improve the quality, quantity and efficiency of public improvements.

To eliminate from specifications for public work conditions which are onerous to the contractor and wasteful to the public.

To secure at the hands of public officers equitable treatment and better and more just consideration.

To cultivate a closer tie of fraternalism among contractors.

To improve and relieve conditions and relations in which we have a common interest.

To initiate, promote and encourage the enactment of legislation tending to carry out the objects of the association.

Its membership is composed of firms making a business of contracting for municipal public works in the state of Illinois. The discussions at the convention were along the lines of co-operated effort for the good of the association and the interests it represents. An effort will be made to assist the convention of city officials and engineers in the adoption of standard specifications for paving.

The association was heartily in favor of assisting the supply dealers to eliminate the undesirable contractors. A campaign will be started against the man who is not responsible and who will not pay his bills. Also an effort will be made to eliminate the man who slights the quality of construction.

A special inspector will be employed by the association who will travel over the state and inspect the work of contractors. He will report both to the association and the city in which the work is being done. The object of having this man is to have an unbiased opinion as to construction.

Informal discussions prevailed throughout the entire convention and were heartily entered into by each and every member present.

Election of officers resulted in the following being chosen:

President, Patrick McCarthy, Moline, Ill.

First vice-president, S. A. Tuttle, Decatur, Ill.

Second vice-president, J. A. McGarry, Chicago.

Third vice-president, John Cherry, Jacksonville.

Fourth vice-president, Morris Hoeffkin, Belleville.

Secretary-treasurer, I. T. Lain, Bloomington.

The next convention will be at Chicago in 1911.

THE STEAM TURBINE.

A recent sales report of the Steam and Electrical Department of Allis-Chalmers Company shows how favorably the steam turbine has been received as a prime mover by users of power. A little over four years ago the company obtained the right to manufacture in this country the latest improved type of Parsons machine. The end of the first year saw only one unit in operation; but, since then, there has been a steady and rapid growth in sales, which has reached a total capacity of over 300,000 horse-power. Of this aggregate 48.2% were sold during 1909 and 20.6% have been placed on orders since January 1, 1910. A large proportion of the units have been for use by power, lighting and railway companies and approximately 40% of the total sales were for this purpose, textile manufacturers being next with 14% of the machines. Practically every type of industrial enterprise is represented in the buyers of these turbines, including gas plants, cement mills, mines, lumber mills, flour mills, paper factories, tanneries, celluloid works, etc. In geographical distribution the machines are to be found in nearly every state in the Union and also in Canada and Mexico. The new cement mills which have installed them are the Security Cement & Lime Co. and the Clinchfield Portland Cement Co. The Golden State Portland Cement Co. and also the Casparis Stone Company have purchased turbines.

CONCRETE DEPOT AND HOTEL FOR BARSTOW, CALIFORNIA.

The contract to erect the large reinforced concrete depot and hotel building at Barstow, California, for

the Santa Fe Railway Co. has been awarded to C. A. Fellows, Central Building, Los Angeles, at approximately \$210,000. In reality three buildings will be built—the station proper, one-story and basement, 130x60 feet; the hotel, two stories and basement, 175x135 feet and the recreation hall, two stories and basement, 165x50 feet. Francis W. Wilson, Kerckhoff Building, Los Angeles, is the architect.

BUSINESS NOTES.

The Lock Joint Pipe Company, 165 Broadway, New York, has been awarded a contract for 200,000 ft. of Meriwether reinforced concrete pipe in sizes of 36 to 84 in. for the sewerage system of Havana. The Cuban Engineering & Contracting Company, New York, has the general sewerage contract. The Lock Joint Pipe Company has also closed contracts for new sewers in East Orange, Newark and Paterson, N. J., and Brantford, Ont., Canada.

Griot's deflectometer, an instrument being placed on the American market by the Reinforced-Concrete Company, Wright Building, St. Louis, is used for measuring the deflections of bridges and reinforced concrete floors and columns. It has an enameled scale, 3 1/4 in. in diameter, and is graduated to 0.01 in., enabling reading to be made to 0.001 in. The motion is transmitted to the indicating hand by a weighted wire which passes between two rollers. One of these actuates the hand mechanism, and the other has a spring against it in order to secure proper pressure on the wire.

CEMENT BOOKS

How to Use Portland Cement	- - -	50 Cents
Cement Sidewalk Construction	- - -	50 Cents
Hollow Concrete Building Block Construction		50 Cents
Monier Cement & Steel Construction	- -	50 Cents
The Constitution of Hydraulic Cements	-	50 Cents
<i>(By DR. W. MICHAELIS, Sr.)</i>		
The Hardening Process of Hydraulic Cements		50 Cents
<i>(By DR. W. MICHAELIS, Sr.)</i>		
Architects & Engineers Handbook of Reinforced		
Concrete Construction, Paper Cover	-	\$1.00
Cloth Cover	- - -	2.50
<i>(By L. J. MENSCH)</i>		

Delivered Free on Receipt of Price.

Address Cement & Engineering News
22 Fifth Avenue, Chicago

POPULARITY OF CONCRETE BLOCKS IN SCOTLAND.

Consul J. N. McCunn, of Glasgow, reports the growing popularity of concrete blocks in Scotland for house construction: Two years ago the merits of hollow concrete-block construction were hardly known in Scotland. Since then a number of tenement houses, cottages and villas have been erected with these blocks in and near Glasgow, the experiment convincing the builders that they cost less than stone for buildings, are equally as substantial, and more pleasing to the eye. For centuries stone has been the chief building material in Scotland and the finest skilled labor has been employed in stone construction. With the introduction of concrete-block machinery, it has been demonstrated that the blocks may be turned out with ordinary labor, and that the machine is comparatively inexpensive and easy to operate.

A Glasgow dealer has secured the agency for an American concrete-block machine and has already sold a large number of them. This dealer is enthusiastic over the prospect, and states that there is a great future for concrete-block building in Scotland, and now that the first step has been taken others will follow by using this material for every class of building. Within slightly over a year's time there have been constructed in or near Glasgow approximately \$150,000 worth of new concrete buildings.

It is claimed that the American machines tried so far are more efficient than those of British or other make, and that they can be sold here at a price that will fully meet all competition. In view of this, and that concrete-block construction bids fair to become a large factor in building operations throughout Great Britain, it would seem that there is an excellent opportunity for American manufacturers of cement and concrete molding machinery.

Hess Furnaces



No. 45

"Leader" Hess Steel Furnace

Price \$49.00

Delivered East of Omaha and North of Ohio River
Pipes and Registers Extra

for the past 7 years, have been sent to customers in every state in the Union, freight prepaid.

On Approval

and the money held back till sixty winter days of actual trial have proved that all our claims for superiority have been fulfilled.

Isn't this worth looking into? Could we offer such liberal terms if we didn't know that the Hess Furnace excels in service, simplicity, efficiency, economy?

All we ask of you, if you need a furnace, is to investigate—to put your name on a postal card, mail to us and ask us for our booklet "Modern Furnace Heating." This booklet is an authority on furnace heating, and copies have been requested by many colleges, libraries, etc., for reference in engineering and mechanical courses. It instructs fully in the principles and practice of furnace heating, and should be in the hands of every builder and house owner. It is free on request.

In Buying Direct

From Our Factory You Pay Only One Profit—A Small, Factory Profit.

Our prices are not inflated with the usual cost for salesmen, branch stores, agents' and dealers' profits. The factory profit only, satisfies us, and you will be surprised at how much we can save you.

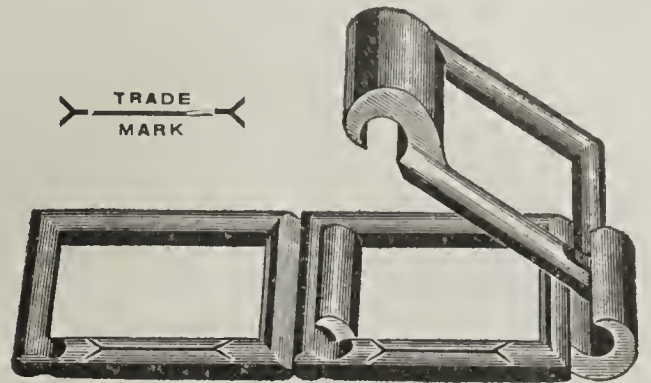
Special Heating Plan Free Before You Order

Let us have our experts prepare a special plan for heating your building. It will cost you nothing, and put you under no obligation to buy of us. Our thirty-six years of experience in designing heating equipments makes this free plan valuable to you.

Ask us more about it. A postal card today will serve the purpose.

Hess Warming & Ventilating Co.
919 Tacoma Bldg., Chicago.

Original "Ewart"



Detachable Link-Belt

and our other approved chains, attachments, etc., described and illustrated in Link-Belt Catalog No. 75 A

> Flint-Rim < Sprocket Wheels

FOR DURABILITY



Trade Mark—Reg. U. S. Pat. Office.

Made to Fit the original "Ewart" and other chains of our manufacture.

Cost but little more than ordinary cast iron wheels.

Prompt shipment follows every order.

ASK FOR BOOKLET.

LINK-BELT COMPANY

PHILADELPHIA

CHICAGO

INDIANAPOLIS

NEW YORK, PITTSBURGH, ST. LOUIS,
299 Broadway, 1501-2 Park Bldg. Central Nat'l Bank Bldg.

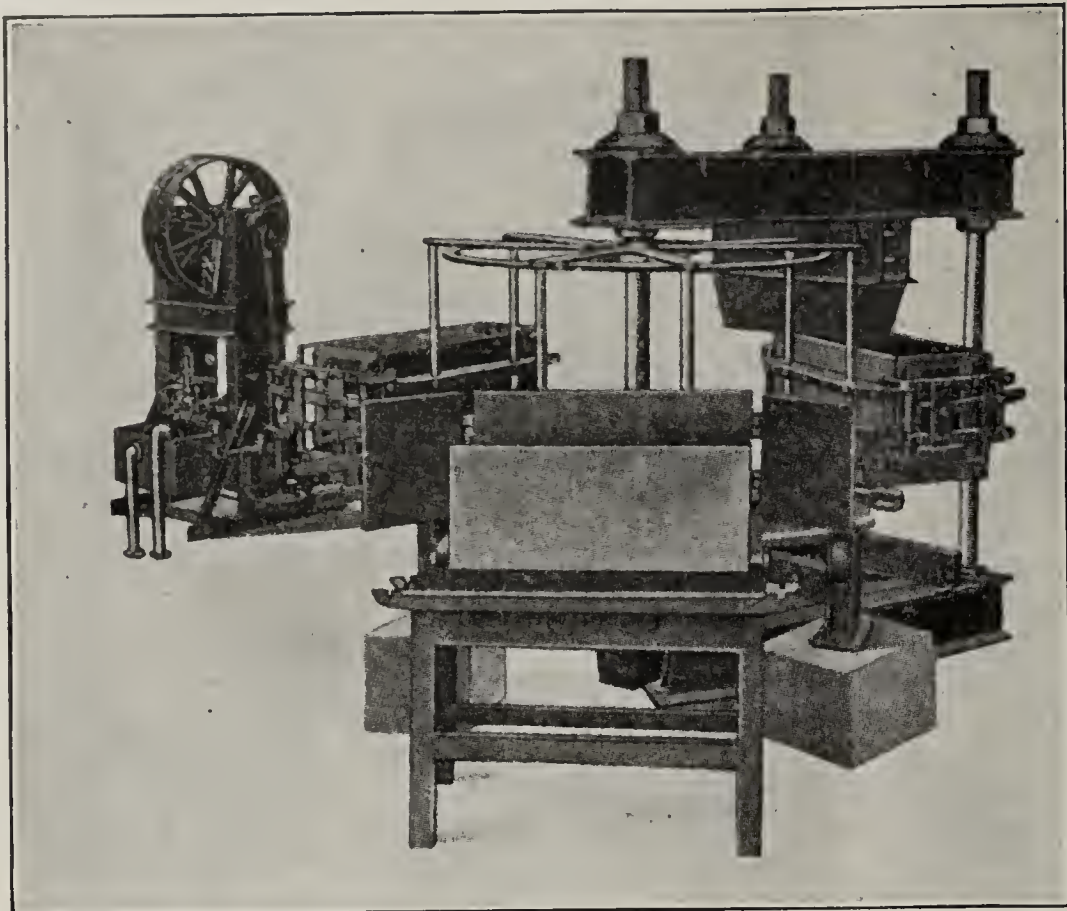
SEATTLE,
439-440 N. Y. Block.

DENVER,
Lindrooth, Shubart & Co.

NEW ORLEANS,
Wilmoth Machy. Co.

SAN FRANCISCO—Eby Machinery Co.

A DENSE CONCRETE



A Hydraulic Ram Pounding Concrete Into Blocks

TWO MEN do the work. From 1000 to 2000 blocks per day. Three quick-acting mold boxes rotating over the Ram on a Revolving Table, one being filled, one receiving the pounding, one delivering the finished block.

The Fisher Hydraulic Machine pounds a wet mixed mortar together with a Hydraulic Ram and produces a dense concrete with less than 5% absorption, with a high crushing strength, in any style to suit the demand.

Ask for Catalogue or any information regarding our system.

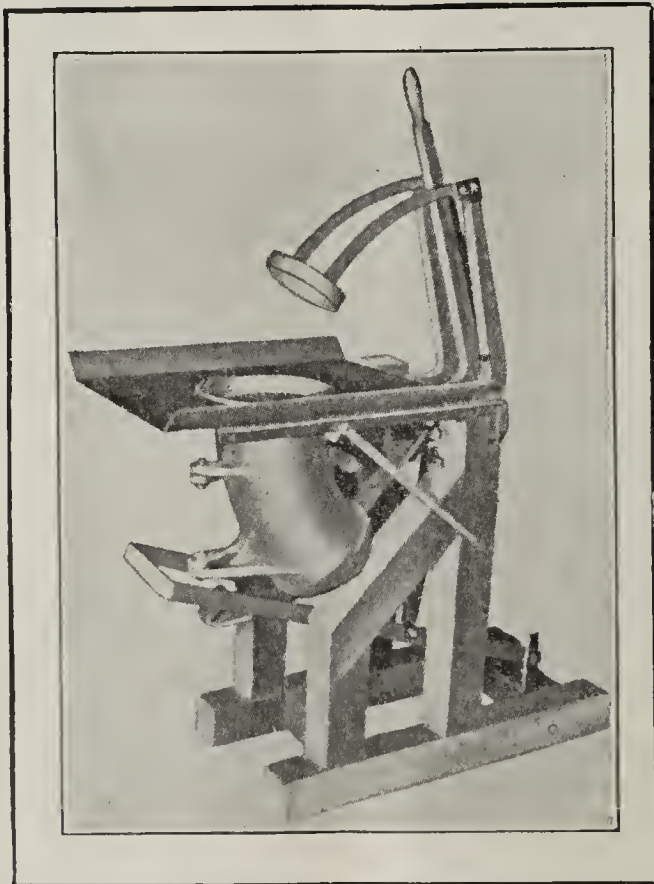
Fisher Hydraulic Stone & Machinery Co.

Builders' Exchange Building, Baltimore, Md.

Concrete Sewer Pipe Bends

The Only Machine
of Its Kind
on the Market.

Concrete Sewer Pipe
Bends Made on the
**RICKMAN SEWER PIPE
BEND MACHINE** Make
Money for the Manu-
facturer.



The Latest Thing
Added to the Concrete
Machinery Line.

ONE MAN can make from 15 to 20 curved sections of pipe per hour. Shovel in the material, tamp it with the tamping ring, operated by foot lever, attach the bell-end form, complete the section, withdraw core from below, by lever, carry the pipe away to a pallet and bring the outer mold back to the machine.

You Need This Machine to Complete the Equipment of Your Tile Factory

Write for Circulars and Prices

R. L. RICKMAN CO.,

987 Westminster Avenue,
VANCOUVER, B. C.



The Hoisting Engine That "Stays Put"—

¶ Just *that!*

¶ The hoisting engine that "stays put"—

¶ In other words, the hoisting engine which, when "put" together and delivered on the job, will "stay" in alignment *permanently!*

¶ In *which* respect it differs radically from all other hoisting engines.

¶ This statement being, not a matter of opinion, but of FACT, due to a fundamental difference in construction, to-wit—

The Wrightworth Hoisting Engine is built with a one-piece side frame.

¶ And, now, you say, what does *that signify?*

¶ Why, *everything!*

¶ First, that the machinery is very *rigid*, and very *strong!*

¶ But, more specifically, that—

The lower halves of all bearings are cast in the frame.

¶ There you have it! A feature of vital importance!

¶ Nothing to jar or jolt loose and throw the engine out of alignment.

¶ The only bolted parts are the *caps* on the bearings—the bearings themselves are cast in the frame and cannot be dislocated even if the caps *should* work loose; hence—

It is a physical impossibility for a Wrightworth Shaft to be out of alignment.

¶ Again, the cross-head guide support is a part of the frame—*not* bolted to it—no chance for it to work loose, bend the piston-rod and cause a breakdown.

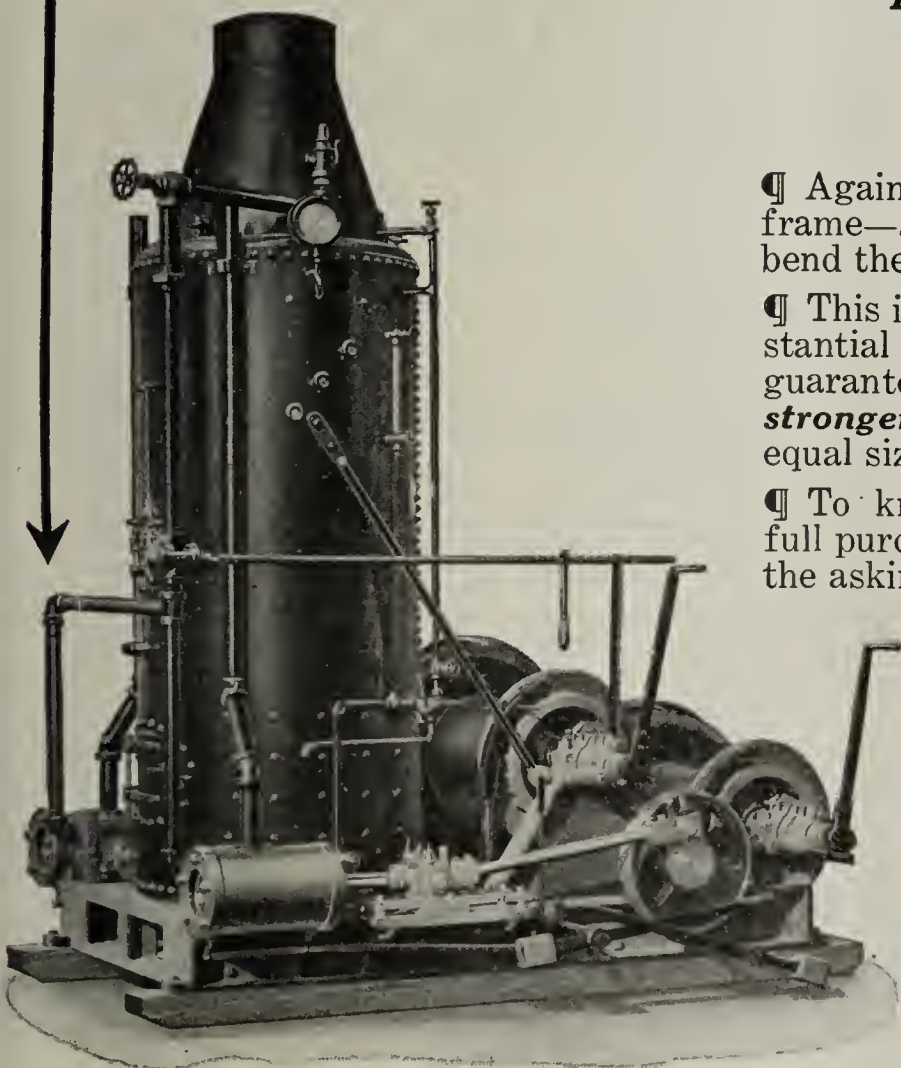
¶ This is why the Wrightworth is by far the most substantial hoisting engine made; it's *why* we write into the guarantee under which the Wrightworth is sold that it is *stronger* and will outlast any other hoisting engine of equal size.

¶ To know the Wrightworth thoroughly is to realize the full purchasing power of your money—full information for the asking!

William B. Hough Company

"Where the good contractor's machinery comes from"

Monadnock Block, Chicago, U. S. A.



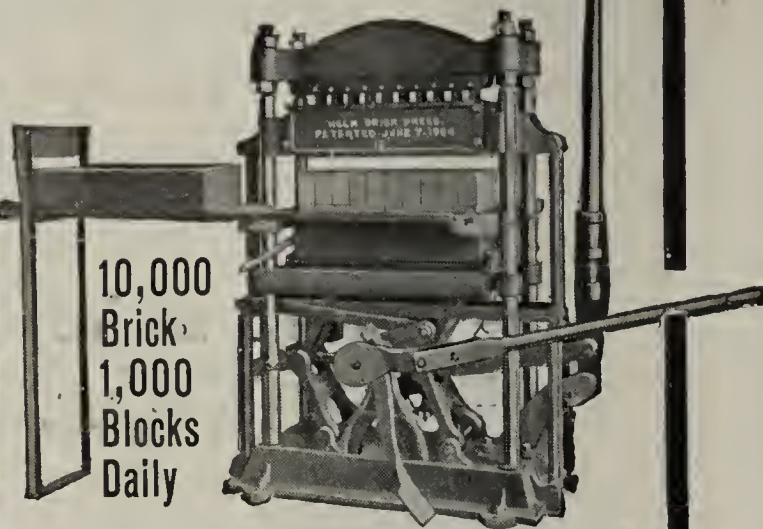
BIG MONEY FOR YOU

In Pressed DRY-WALL Blocks and Brick

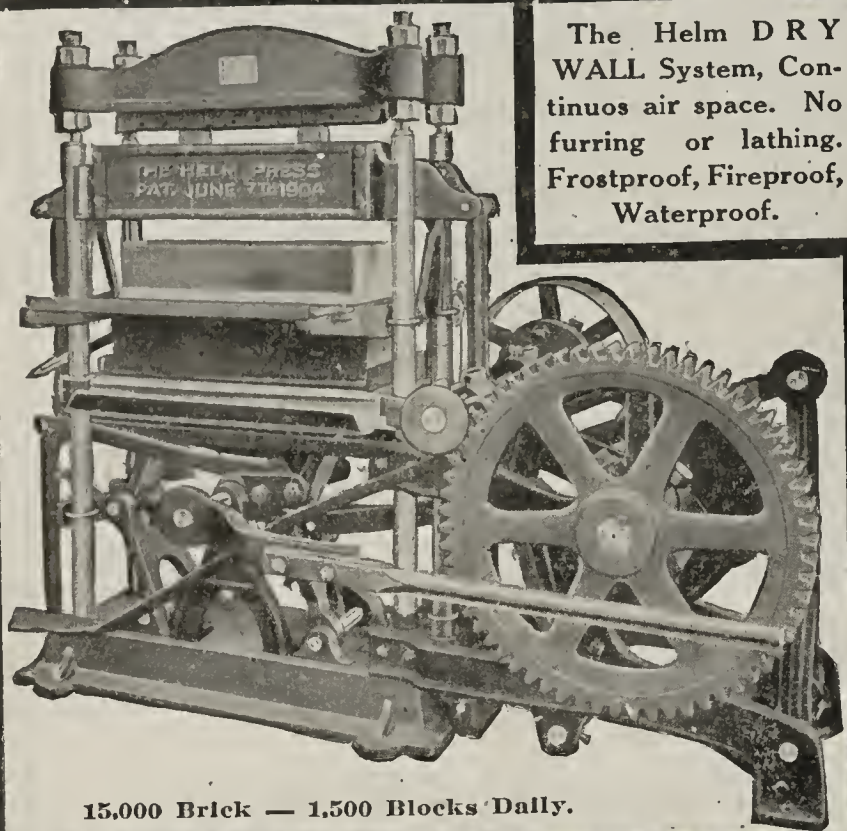
Helm Presses make as high as \$50.00 daily. You can secure the cream of the concrete business with their superior product. Unequalled for beauty, strength, adaptability and cheapness. Daily displacing machines of every description.

The 80,000 lbs. pressure of Helm Brick and Block Presses make the strongest and most uniform concrete product. A 6 to 1 brick only 27 days old stood 85,000 pounds compression, for excelling all other tests. Heavy pressure on medium wet concrete secures this wonderful result with the least cement. A Helm Press and the medium wet mix is the only sure and certain method. You're bound to adopt it in the end. You'll save money by adopting it now. No "extras" to buy with Helm outfits.

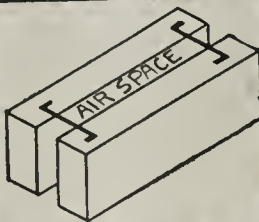
80,000 lbs.
Pressure



10,000
Brick
1,000
Blocks
Daily



The Helm DRY
WALL System, Con-
tinuous air space. No
furring or lathing.
Frostproof, Fireproof,
Waterproof.



Investigate the Helm Hand and Power Presses

if you want to control the big contracts in your locality. You can outstrip competition. You can manufacture cheaper, make better product and get better prices and more business.

Send the Coupon for free Concrete Book

Profusely illustrated with half-tones and diagrams of machines, product and building forms. Shows how to secure dry walls. Don't buy without first getting this book. Send the coupon right now for your copy, free and prepaid.

HELM BRICK MACHINE COMPANY,
214 Bank Building, Traverse City, Mich.

HELM BRICK MACHINE COMPANY,
214 Bank Bldg., Traverse City, Mich.

Send me the free book on concrete. Interested in ☐ Blocks,
Brick. ☐ Mixers. ☐

NAME

ADDRESS

PATEK'S CONCRETCOTE

INSIDE AND OUTSIDE FINISH FOR CONCRETE.

This special concrete finish waterproofs concrete, and is practical to use under all working conditions, unaffected by dampness, gases, smoke, oil, etc. Gives uniformity of color to concrete, covering joints, dirt streaks, etc. Concretcote does not crack, peel or blister.

A PERFECT, PRACTICAL STAIN FOR THE EXTERIOR OF STUCCO AND CONCRETE HOUSES.

WALLS—Wall Concretcote is the only remedy for saltpetre trouble. Recommend it and figure it on your jobs, and you will avoid the difficulties encountered when saltpetre comes in contact with oil and water paints.

FLOORS—Floor Concretcote penetrates the concrete deeply and evenly, seals the pores and amalgamates with the material, forming a moisture proof surface. Gives an elastic, linoleum-like surface, non-porous and washable, which resists the pulverizing of cement by heavy traffic.

Write For Free Booklet Showing Colors:

PATEK BROTHERS, Sole Makers, MILWAUKEE.

Cement Mill Machinery

A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process.

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



Write for Catalogue No. 17.

Power & Mining Machinery Company

MILWAUKEE, WIS., U. S. A.

CHICAGO.

NEW YORK.

ATLANTA.

EL PASO.

SAN FRANCISCO.

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

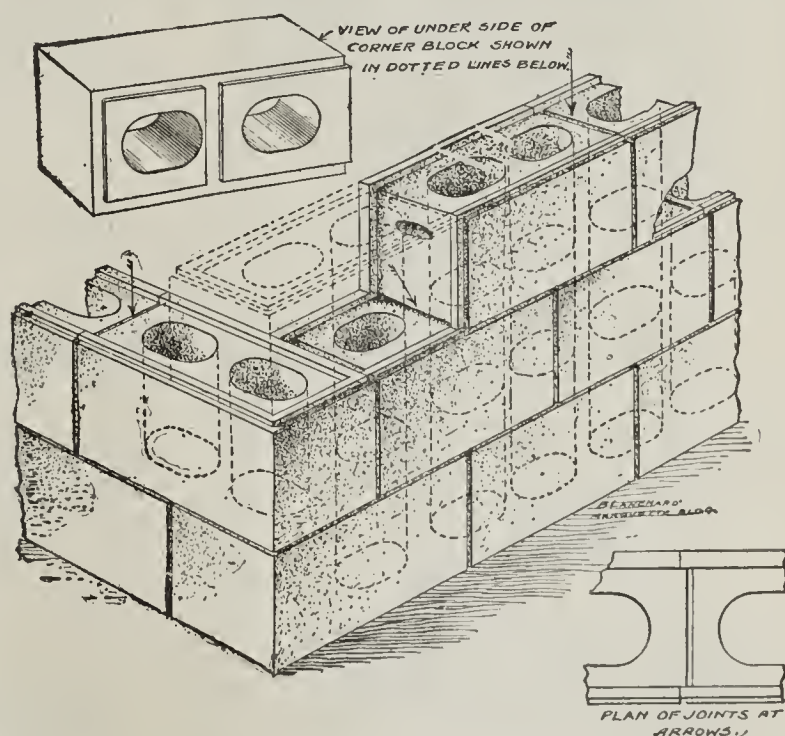
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting Face-Down Machine by the Wet Process

The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and agents wanted in all states and foreign countries.



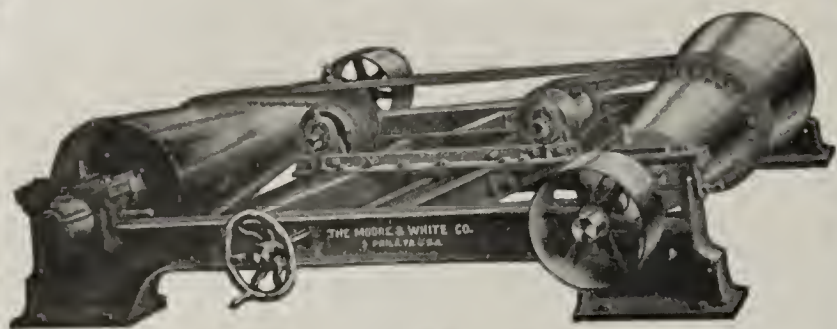
DIAMOND CONCRETE MACHINERY COMPANY

Tacoma Building,

- - - - -

Chicago, Illinois

It will be to any Mill Owner's advantage to investigate these two economical Power devices.



M. & W. Speed Change.

Power
Transmission
Machinery
for
Cement
Mills.



Friction Clutch Pulley.

Write for

Catalogue.

The Moore & White Co.,
Philadelphia, Pa.



Sampling Universal Portland Cement

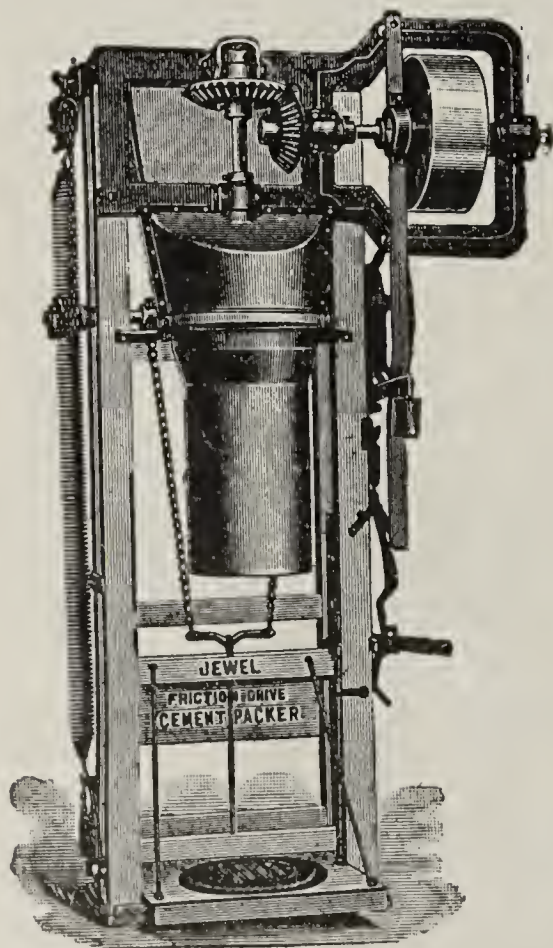
four hundred and fifty times an hour as the finished product leaves the mill is one illustration of the thoroughness and care exercised at every stage in its manufacture. Our method of obtaining fair samples by means of an automatic device which removes from the conveying belt entering the storage bins a certain quantity of cement every eight seconds, was originated and is employed exclusively by this Company.

Universal Portland Cement Co.

Chicago—Pittsburg

Annual Output 8,000,000 Barrels

There is more Cement being packed by the "S. HOWES" Company's Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and sacks.

The "JEWEL" FRICTION driven cement Packer, specially constructed for rapidly packing sacks.

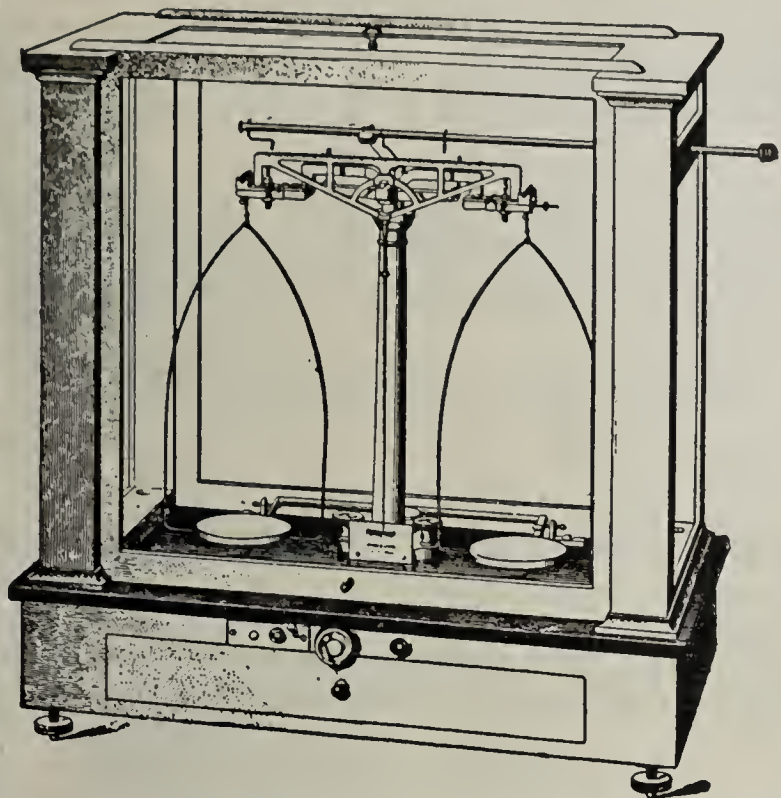
Both machines are equipped with friction pulleys, heavy iron frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company

SILVER CREEK, N. Y.



Apparatus for Chemical and Physical Testing of Cement

EIMER & AMEND

205-211 Third Avenue, New York City

MANUFACTURERS OF & HEADQUARTERS FOR

Chemical Apparatus, C. P. Chemicals and Reagents

Cement Briquette Moulds.

Gilmore Needle.

Standard Sieves of Exact Meshes.

Williams' Sp. Gr. Balance.

*Specially adapted for determining
Sp. Gr. of Cement.*

(Descriptive Pamphlet sent on request)

*Schumann's, Le Chatelier's,
Jackson's and Candelot's
Apparatus for Sp. Gr. of
Cement.*

Headquarters for **Calorimeters and Pyrometers.**

(Our large illustrated Catalogue gladly sent to Chemists on application.)

F. A. Jones, M. E.

Gypsum Specialist

Consulting Mechanical, and Chemical Engineer, in
Designing Construction, and Operation of Plaster Mills,
Mines, and Mixing Plants.

Plans, Specifications, Estimates of Cost, Superinten-
dence of Construction, ROTARY or KETTLE PROCESS.

Examination, Tests, Analysis, and Reports of Gypsum
Properties, Mills Remodeled and Enlarged, Mixing
Plants Erected, and Formulas Furnished.

883 Mahoning Avenue
YOUNGSTOWN, OHIO

WM. B. SCAIFE & SONS CO.

221 First Ave., Pittsburg, Pa.

WE-FU-GO

and **SCAIFE**

Water Softening, Purifying, and Filtering Systems

— FOR —

BOILER FEED

AND EVERY INDUSTRIAL USE.

Send for Complete Information

DEXTER Portland Cement
THE NEW STANDARD

Sole Agents **SAMUEL H. FRENCH & CO.** Philadelphia



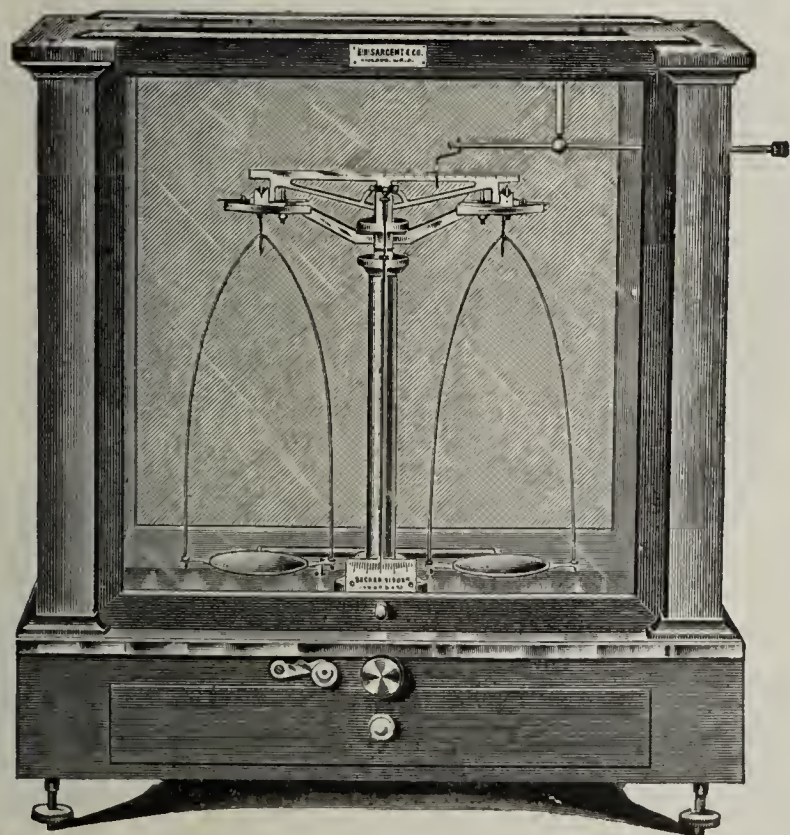
HAVE YOU AN IDEA?

If so write for our books: "Why Patents Pay," "What to Invent," "100 Mechanical Movements" and a Treatise on Perpetual Motion—50 illustrations. All mailed free.

F.G. DIETERICH & CO. Patent Lawyers and Experts

801 Ouray Block

WASHINGTON D. C.



E. H. SARGENT & CO.

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN

CHEMISTS SUPPLIES

Of high grade only.

We call particular attention to our Cement
Mould, Vicat Indenting Apparatus, as im-
proved by us, Gilmore's Needles, Jackson's
specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

CHICAGO



McCaslin Conveyor over Storage Bin Handling Hot Clinker

The McCaslin Conveyor

Acknowledged by Competent Engineers as the best Conveyor in the world for handling hot clinker, stone, etc., in **CEMENT PLANTS.**

Low Cost of Maintenance Absence of Shut Downs
Maximum of Efficiency

Manufactured solely by

Mead, Morrison Mfg. Co.

BOSTON

NEW YORK

CHICAGO

Catalog on Request

Send Us Your Specifications for an Estimate

Face Your Blocks

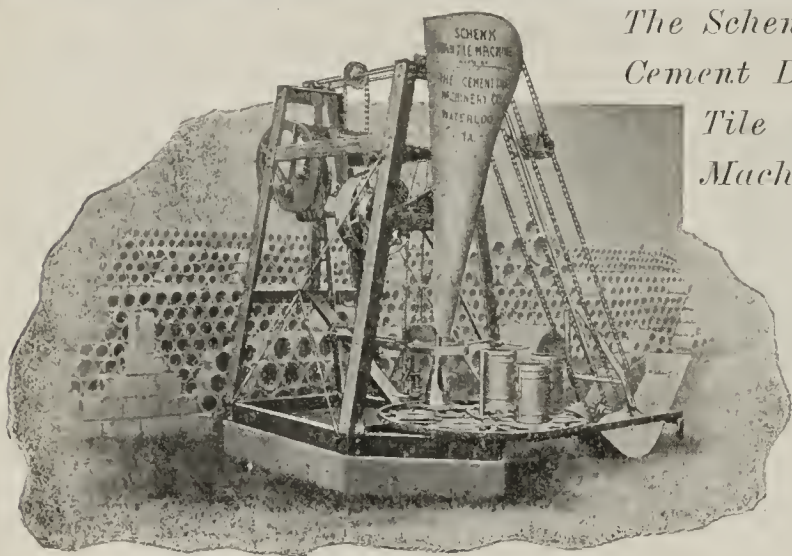
Make Them White

Do You
Use

WHITE SAND

Leading contractors specify our pure White, Washed and Screened Silica Sand for fine work in ornamental stone, block facing, porch work, ornamental lawn fixtures, vases, etc.
This sand is shipped both DRY and DAMP.
Prices and Samples on request.

BALLOU'S WHITE SAND COMPANY
MILLINGTON, ILLINOIS



*The Schenk
Cement Drain
Tile
Machine*

"Money in Cement Tile"

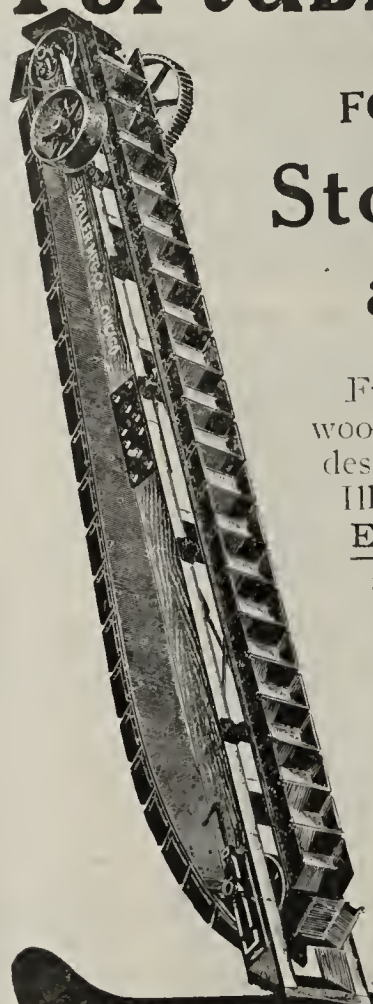
We have just published a little book with this title ; it tells the whole story in a way you will understand.

Write for it today.

The Cement Tile Machinery Co.
WATERLOO, IOWA

Portable Elevators

FOR HANDLING
**Stone, Gravel
and Cement**



Furnished in all designs, with wood or iron frames, and of any desired capacity.

Illustration shows a WELLER-Made Portable crushed stone elevator ; we furnish these for handling all classes of materials.

Send for 512 page catalog on WELLER-Made Elevating, Conveying and Power Transmitting Machinery.

Weller Mfg. Co.

CHICAGO

WELLER-Made

The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa

WANT COLUMNS.

Advertisements in this column are inserted at the rate of two dollars per inch per issue—and no advertisement will be taken for less than two dollars and must be paid strictly in advance.

POSITION WANTED.

Assistant Chemist (Lehigh University), desires position. Am also a first class accountant. Four years' experience. Address Chemist, 330 Fourth St., South Bethlehem, Pa.

WANTED.

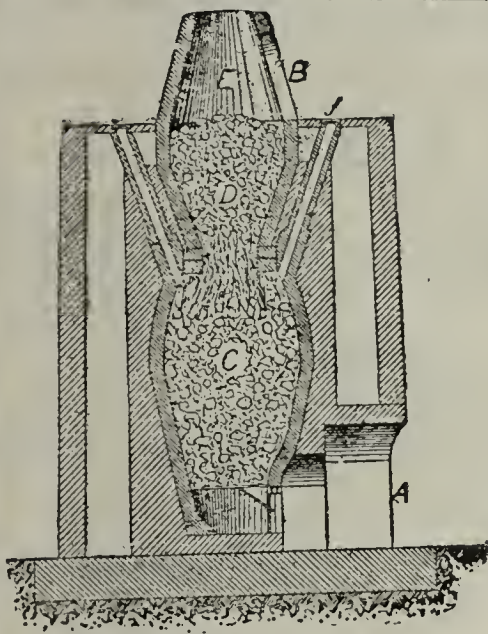
If you are interested in pumps of latest and best styles, send to us for book and catalogue. Pumps of all styles and for all uses. The Columbus Steam Pump Works, West Broad street, Columbus, Ohio.

WANTED.

Position as asst. chemist by a young man with four years practical experience and a good technical education. Address B., care Cement & Engineering News.

CHEMIST having some years experience, is open for a position with a cement company. References furnished. Address O. C., care Cement and Engineering News.

CHEMIST—With 8 years successful and extensive experience as chief chemist desires change of location. References from present and past employers. Address L. G., care Cement & Eng. News.



The Kiln & Chimney Construction Co.

197 HAVEMEYER STREET
BROOKLYN, N. Y.

We build Kilns for burning Lime and Cement, also

CHIMNEYS

REPAIRING and REMODELING
our SPECIALTY

WANTED.

We want to buy at once several second hand concrete building block machines. Also a second hand tamping machine. Address V. L. S., care Cement and Eng. News.

"PLASTER OF PARIS"

American Patent No. 757649 dated April 19th, 1904.
FOR SALE.

This method produces a much better quality than other methods and there is a great saving in the cost of production. The German Patent has been sold and the process can be seen working in England. Apply DUNN BROS. & CO., Manchester, England."

Location for Cement Plant

Extensive Deposits of Raw Material. Proximity to Large and Growing Markets. Low-Priced Fuel Supply.



THERE ARE several desirable locations for Portland Cement Plants along the Santa Fe, where the advantages enumerated are to be found. If you are interested you can secure full and detailed information by addressing this office.

The SANTA FE is glad at all times to co-operate with those seeking locations or desirous of investigating conditions in territory tributary to its line. Correspondence from interested manufacturers is invited.

WESLEY MERRITT, Industrial Commissioner A., T. & S. F. Ry.
1122 Railway Exchange Building
CHICAGO, ILL

The Giant Griffin Mill

40-inch Die . 24-inch Roll
15,000 lbs. Crushing Effect

Will take Portland Cement clinker
 1½ inches diameter from the kiln
 and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

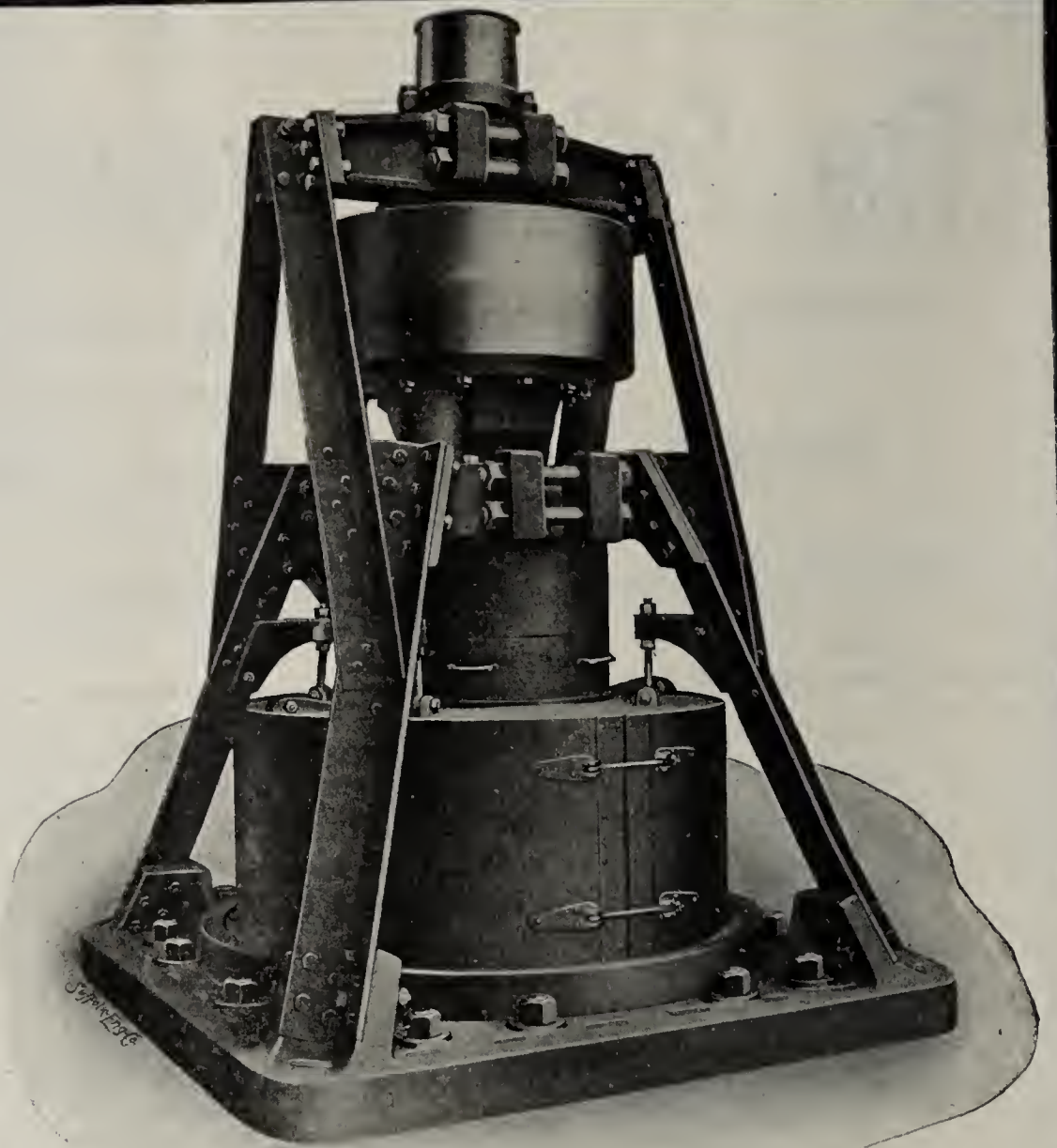
It saves cost in attention.

MANUFACTURED BY

BRADLEY PULVERIZER CO.

37 Walbrook
 LONDON, E. C.

92 State Street
 BOSTON



IRON-ORE CEMENT

The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in place of Portland cement for all Marine Construction.

Send for Literature, Etc.

Worm-Cox Company
SOLE AGENTS

Marquette Building, Chicago

LEHIGH PORTLAND CEMENT



HIGH TENSILE
 STRENGTH
 FINELY GROUND
 LIGHT
 AND UNIFORM
 IN COLOR

Manufactured by
The Lehigh Portland Cement Co.,
 ALLENTOWN, PA.

Western Office:
 725 ROCKEFELLER BUILDING,
 CLEVELAND, OHIO.

ALPHA

PORTLAND CEMENT....

Alpha, N. J.
 Works: Martins Creek, Pa.
 Manheim, W. Va.
 Alsens, N. Y.

Quality
 unexcelled

The Recognized Standard
 American Brand

Always
 Uniform

ALPHA PORTLAND CEMENT CO.

Manufacturers of but one grade—strictly straight Portland
 General Office, EASTON, PA.

JUST A REMINDER

ATLAS DRYERS—DRY NEARLY EVERYTHING

THE ATLAS DRYER CO., CLEVELAND, OHIO

THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

**Design, Construction, Remodeling and Operation
of Portland Cement Plants**

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street
New YorkCanadian Express Bldg.,
Montreal, Can.1121 The Rookery
Chicago425 Washington St.
San Francisco, Cal.Monongahela Bank Bldg.
PittsburghSyndicate Trust Bldg.,
St. Louis, Mo.Norfolk House, Cannon St.
E. C., London

The Osborn Engineering Co. Civil, Mechanical and Electrical Engineers Experts in the Designing of **CEMENT PLANTS.**

OSBORN BUILDING, CLEVELAND, O.

Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of **Cement Machinery**

42 NORTH 16TH STREET

:-:

PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

COMMERCE BLDG.,
Kansas City, Mo.

Cement Engineers

Just Out!

Architects' and Engineers' Hand Book on
**Reinforced Concrete
Construction**

ONLY ONE DOLLAR

CEMENT & ENGINEERING NEWS

22 Fifth Avenue, - - Chicago

Colonial Trust & Savings Bank

A BANK FOR THE PEOPLE

Pays 3% on Savings Accounts

Capital and Surplus, \$1,106,620

YOUR ACCOUNT INVITED

205 La Salle Street, - - - - - Chicago, Ill



THE IMPROVED DIETRICH'S CLAMP

and Form System for Hollow Walls

By the use of the Improved Dietrichs Clamp and Form System for Hollow Walls the

**COST OF CONCRETE
CONSTRUCTION IS
REDUCED 50%**

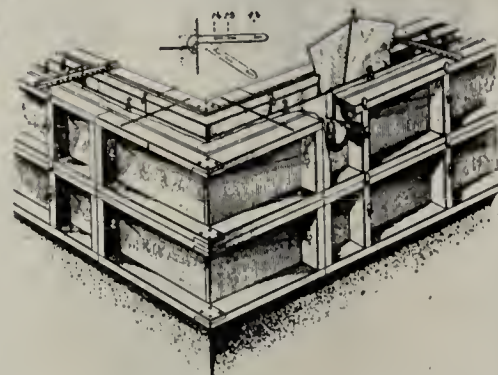
and the builder also secures a

**PERFECT
DAMP-PROOF WALL**

This system is based on the panel principle and employs removable sheet iron inner forms with sheet iron spacer. Corners, doors and window openings are provided for.

Write for pamphlet giving full information

DIETRICH'S CLAMP CO.
LITTLE FERRY, N. J.



ELEVATING—CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys,
Shafting, Shaft Bearings, Link Belting, Special Chains



HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES.
Catalog for the asking.

SKILLIN & RICHARDS MFG. CO., CHICAGO



OUR POLE DERRICK is built light and strong. Average length 18 ft.; weight 200 lbs.; capacity 1800 lbs.; equipped with 100 ft. cable block and rollers ready for use \$26.50 F. O. B. Chicago.

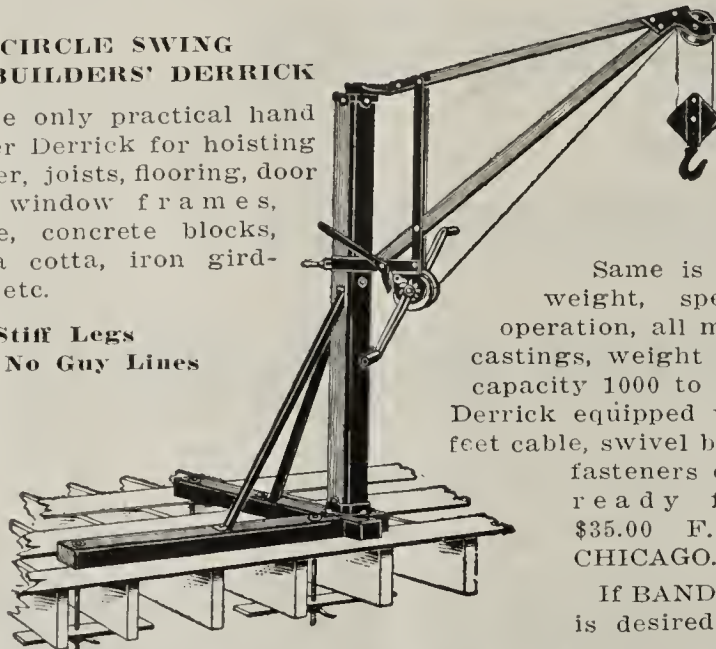
THE SASGEN BUILDERS' DERRICKS

The Latest Inventions in
HOISTING APPARATUS

Our CIRCLE SWING BUILDERS' DERRICK

is the only practical hand power Derrick for hoisting timber, joists, flooring, door and window frames, stone, concrete blocks, terra cotta, iron girders, etc.

No Stiff Legs
No Guy Lines



Same is light in weight, speedy in operation, all malleable castings, weight 250 lbs.; capacity 1000 to 1500 lbs. Derrick equipped with 110 feet cable, swivel block and fasteners complete ready for use, \$35.00 F. O. B. CHICAGO.

If BAND BRAKE, is desired, add \$1

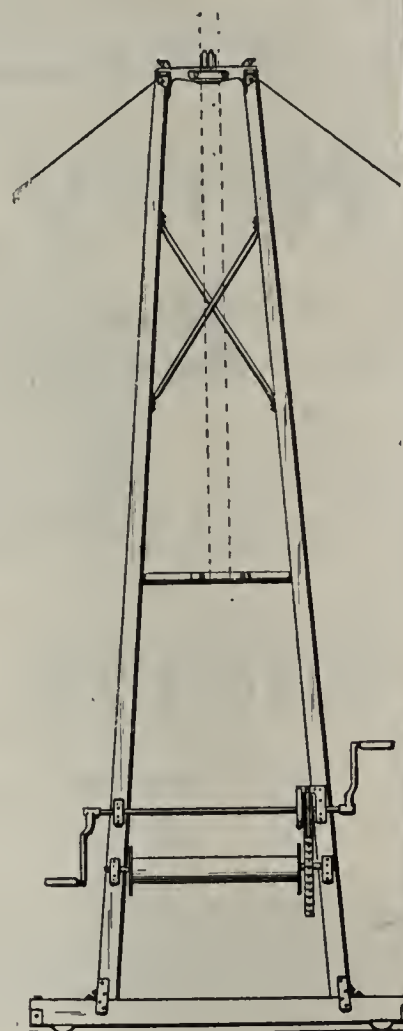
We keep all these machines in stock and can fill orders promptly.

SASGEN BROS.

2053-57 Racine Ave., - - - CHICAGO, ILL.

New York Office, 103 Park Ave.

Write for Illustrated Catalogue "C"



OUR SASGEN IMPROVED SETTER DERRICK including a top shive frame, extension clamps, etc. Price of 20 ft. lengths \$42.00 F. O. B. Chicago.

N

\$19.00

Porch Column and Pier Outfit

Jobbers and Dealers Wanted



Looks well on any house, hundreds in use
Concrete specials bring **BIG PROFITS.**

If you don't own a Porch Column Outfit you
are not getting the most out of your business

Concrete Machinery Bargains

Sill and Cap Mould....	\$11.50
Chimney Moulds.....	5.25
Block Machines.....	10.00
Hand Mixers.....	22.00
Power Mixers.....	50.00
Brick Machines.....	18.50
Tile Moulds.....	6.25
Silo Machine.....	10.00
Ball Moulds.....	2.55
Gasoline Engines.....	40.00

Everything Sold by the Pound

Send for big 1910 catalog
which describes dozens of
different block machines,
brick machines, ornamental
moulds, silo machines, hand
and power mixers, tile
moulds, post machines, ball
moulds, in fact everything
that may be desired in this
line. It will save you money.

We make everything in the Concrete Machinery Line.

Northwestern Steel and Iron Works

Box 810 EAU CLAIRE, WISCONSIN

N

MEDUSA WATER-PROOF COMPOUND

Makes all concrete watertight

Write for pamphlet describing its use. Do not accept a substitute, as there are many adulterated compounds on the market.

It is not a wash, or an experiment



Illustration of Soulard Public Bath House, St. Louis, Mo. Pool, Floors, Steps and Walls surfaced with Medusa Pure White Stainless Portland Cement, containing Medusa Water-proof Compound.

Sandusky Portland Cement Company

Sandusky, Ohio

Write for free Sample of our White Portland Cement

Obtain our prices on Medusa Portland Cement. Annual Capacity, 1,500,000 bbls.



"RESULTS COUNT"

ROCK CRUSHERS.

1—9 x 15 Allis Chalmers Jaw Crusher.

ROCK DRILLS.

6—Ingersoll-Sargeant Rock Drills, size 3 1/4 inches.

6—Ingersoll-Sargeant Rock Drills, size 3 1/8 inches.
Fitted for steam or air.

HOISTING ENGINES.

1—12x16 double cylinder, heavy duty LIDGERWOOD hoisting engine.

1—6x8 Marine Iron Works double cylinder, single drums, reversible in steam chest.

PUMPS.

2—24 inch Centrifugal pumps, 2 to 3,000,000 gallons capacity.

1—20x13x12 Wheeler & Tappan Duplex Pump.

IRON PIPE.

70,000 ft. 1 inch Standard Pipe, 35,000 ft. 1 1/4 inch Casing.

5,000 rolls rubber, leather and canvas belting, structural iron, shafting, pulleys, couplings, steel wire and manila rope. Smoke stacks, corrugated roofing and siding, hose hydrants, tanks. We can save you money on anything you require.

SEND FOR OUR NEW 500-PAGE CATALOG NO. 962.

A wonderful book of facts and information of the utmost value to everyone. Send to-day. It will cost you nothing.

CHICAGO HOUSE WRECKING CO., 35th and Iron Sts., CHICAGO, ILL.

A FEW MINUTES SPENT INVESTIGATING OUR STOCK AND PRICES WOULD RESULT IN A SAVING TO YOU OF FROM 30 TO 75 PER CENT. SEND US AN INQUIRY.

4—250 K. W. Walker Direct Current, 550-volt generators.

1—72 K. W. Stanley A. C. Rotating Field Generator, 2,400-volt, 1,600 alternations; complete with 110-volt exciter; driven by Armington & Sims Automatic Engine

1—10x10x10 Stillwell-Bierce Air Compressor.

4—25-in. double leather belts, 75 ft. each.

1—12-inch double leather belt, 40 feet.

1—12x15x15 Worthington Duplex Condenser Pump.

3—250 H. P. Wickes Bros. Vertical Boilers, 135 pounds pressure.

5—200 H. P. Wickes Bros. Water Tube Boilers, 135 pounds pressure.

2—12x7x12 Blake Duplex Steam Pumps.

1—10x6x12 Blake Duplex Steam Pump.

1—18x26x24 Dean Duplex Condenser Pump

1—10x12 Kingsford Centrifugal Circulating Pump.

1—Complete coal handling equipment, driven by 30 H.P. 550-v. railway motor.

50,000 ft. 1 1/2 inch Standard Pipe, 40,000 ft. 3 1/4 inch Casing.

30,000 ft. 2 inch Standard Pipe, 60,000 ft. 3 1/4 inch Casing.

2,000 ft. 10 inch Standard Pipe, 8,000 ft. 5 1/8 inch Casing.

4,000 ft. 12 inch Standard Pipe, 9,000 ft. 6 1/4 inch Casing.

30,000 ft. 8 inch Cast Iron Pipe, 1,000 ft. 6 5/8 inch Casing.

300 ft. 24 inch Cast Iron Pipe, 1,250 ft. 8 1/4 inch Casing.

1,500 ft. Riveted Steel Pipe, 24 inch to 72 inch diameter.

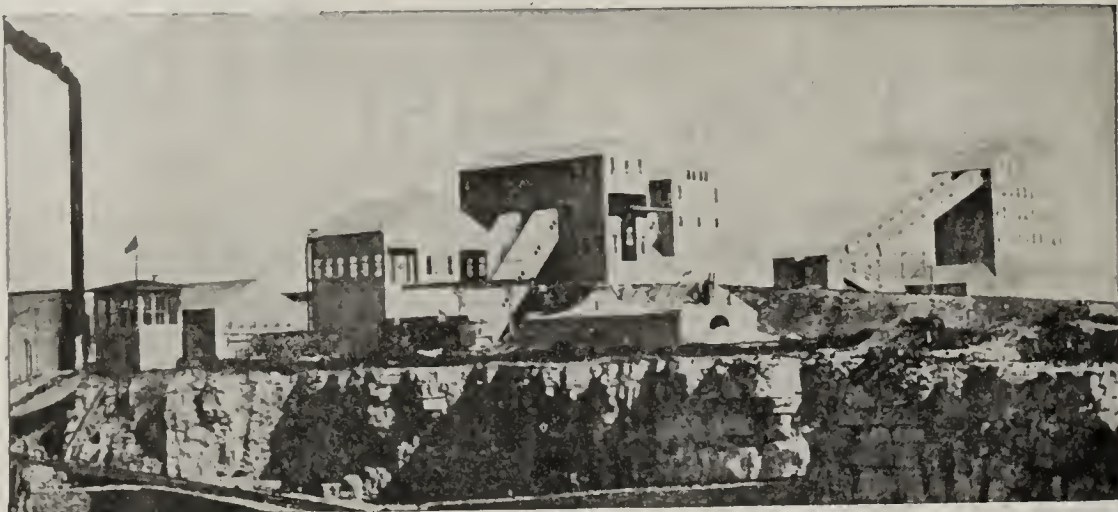
LOCOMOTIVES AND CRANES.

2—9x16 inches Baldwin. 36 inch gauge.

POWER MACHINERY.

1—20x42x33 Cross Compound Buckeye Engine, direct connected to 550-volt General Electric Co. direct current generator

4—15x26x16 Ball Cross Compound Automatic Engines.



Dolese & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world. Machinery throughout installed by us.

OLSON BROS. & CO.

Engineers and Contractors

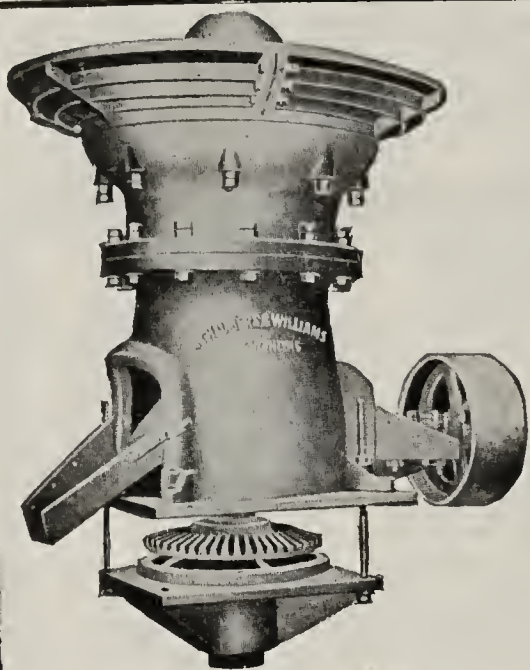
Cement Mill Machinery Erected, Stone Crushing
Plants Equipped and Erected. :: :: ::

ALSO COMPLETE PLANTS FOR HANDLING
COAL, SAND, GRAVEL, ORES, ASHES, ETC.

MODERN POWER TRANSMISSION
Elevating and Conveying Machinery.

Tanks and Vats, Especially in Connection with Machinery

2418-22 Bloomingdale Ave., Chicago



Kennedy Gyratory Crusher

The only Crusher built with a ball and socket eccentric which will lend itself to any change in the inclination of the main shaft. Improved hopper, more efficient dust collars.

— ALSO —

Cement Making Machinery

Kilns, Dryers, Tube Mills, Ball Mills, Elevators, Conveyors, Feeders,
Revolving Screens and Crushing Rolls.

Chalmers & Williams Inc.

1927 Commercial National Bank Building, - - - Chicago
120 Liberty Street, New York



TRADE MARK

PENINSULAR PORTLAND CEMENT

Acknowledged by competent Architects and Engineers
to be unequalled for fineness, wonderful development
of strength and sand carrying capacity.

"THE BEST IS THE CHEAPEST"

Address

Peninsular Portland Cement Co.
JACKSON, MICHIGAN.

Fire Brick Linings For Cement Kilns

STANDARD TESTING SAND AND
GENERAL BUILDING SUPPLIES

Garden City Sand Co.,
188 Madison St., Chicago

Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - - - 645 No. Sixth St., Terre Haute, Ind.

Channon's New Catalog No. 50

**of Contractors' Machinery
and General Supplies**

Ready for Distribution

Send for it

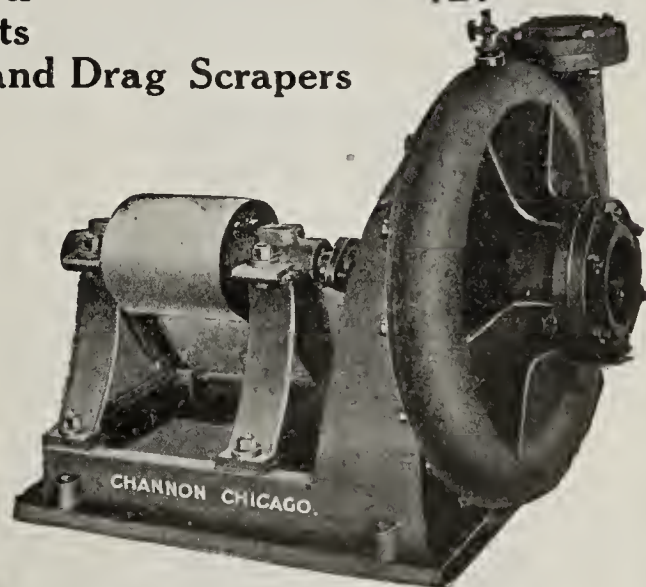


Mundy Hoisting Engines

This catalog describes machinery and general supplies of all kinds for contractors, bridge builders, cement plants, quarries, mines, mills, machine shops and other industries. This is a valuable book giving weights, prices, etc., and is sent without charge to those interested.

Here are a few of our Contractors' Specialties:

Channon Rotary Scraper Excavators
Hadsel Slack-Cable Scraper Excavators
Mundy Hoisting Engines
Channon Derrick Irons
 " Concrete Mixers
 " Material Elevators
Hayward Orange Peel and Clam Shell Buckets
Stuebner Concrete and other Hoisting Buckets
"K & J" Cars, Wheelbarrows, Carts, Wheel and Drag Scrapers
and Plows
American Saw Mills
Witte Gasoline Engines
Cameron Simplex Steam Pumps
Channon Centrifugal Pumps
Channon Diaphragm Trench Pumps
 and a Complete Stock of
Hand Tools, Jacks, Shovels, Rope,
Blocks, Etc.



Channon Centrifugal Pumps

H. Channon Company.

Manufacturers

Chicago

Selling Agents

IT WILL PAY YOU TO USE CROWN HYDRATE

(HIGH CALCIUM HYDRATED LIME)

For Waterproofing and Concrete

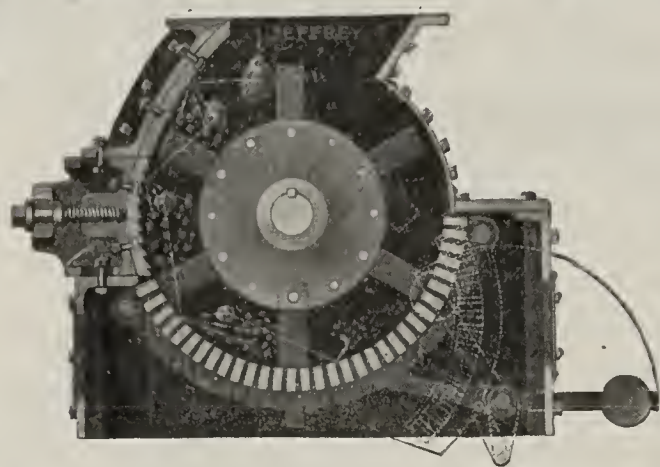
It Improves Its Strength and Color. Ask the

Marblehead Lime Company

KANSAS CITY

CHICAGO

JEFFREY TYPE "B" SWING HAMMER PULVERIZER



For Limestone, Gypsum, Shale,
Fireclay, Phosphate Rock, etc.

has a large capacity and yields a more uniformly fine product, consumes less horse power per ton of capacity and costs less for up-keep than any other machine of its kind. Send for our Pulverizer Catalog No. 31.

We design and build elevating and conveying machinery for all purposes. Revolving and shaking screens, dump cars, excavating and screening plants, etc.

THE JEFFREY MFG. CO.

COLUMBUS, OHIO

New York Chicago Pittsburg St. Louis Denver Boston Charleston, W. Va. Montreal, Can.

Peerless Portland Cement

MANUFACTURED AT UNION
CITY, MICH.

**Every Barrel
Guaranteed**

Fineness, Uniformity of Color
and Sand Carrying Qualities
equal to any Portland Ce-
ment Manufactured

**German-American Port-
land Cement Works**

OWL CEMENT

Illustrated Pamphlet Mailed on Request

E. L. COX, General Sales Agent,
1527 Marquette Bldg.,

Works: La Salle, Ill. CHICAGO

MEACHAM & WRIGHT CO.

Sales Agents

IMPROVED

UTICA HYDRAULIC CEMENT

And Dealers in

LEHIGH PORTLAND CEMENT

Telephone Main 59 206 La Salle St. Chicago

F. D. MEACHAM, Pres.
S. P. BLOUNT, Treas.

F. S. WRIGHT, Vice-Pres.
C. M. FOSTER, Secy.

Improved Canvas Stitched Belting



We Specialize in making Belts
for use in Cement Plants.

Light or Heavy Transmission,
Elevator or Conveyor Belts for
Wet, Dry, Hot or Rough condi-
tions.

Sawyer Belting Co.

Cleveland, O.

Send for Book "K."

Why Don't You?

Make Your Own Cement in the manufacture of SILICATE BRICK and STONE out of Sand, Slag, Quarry-Waste, or any silicious material, with a small percentage of Lime.

Our "DIVISION-METHOD" will produce a higher grade product at a lower cost than can be made under any other process.

"RAW MATERIAL TO FINISHED PRODUCT—24 HOURS."

We furnish all Machinery, erect complete Factory and turn it over in perfect running order.

Write for full particulars to

International Sand-Lime Brick & Machinery Co.

90 WEST STREET, NEW YORK CITY

ENGINEERS AND CONTRACTORS FOR SILICATE BRICK AND STONE FACTORIES.

The Right Power For Concrete Workers

YOUR engine is in the I H C line. For you want greatest efficiency, combined with economy, simplicity, strength and durability. Your engine must work hard, in all kinds of weather, under the most trying conditions. That is why

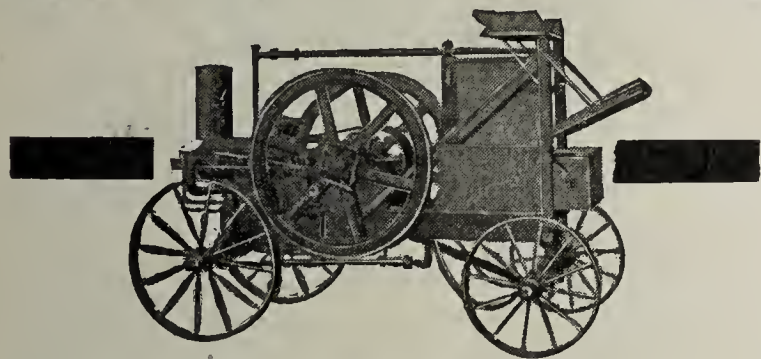
I H C Gasoline Engines

have been the choice of concrete workers who want the right power. See the local International agent about the I H C engine to meet your requirements. Any horsepower, vertical or horizontal, stationary or portable, air or water cooled, mounted on skids or trucks. Catalogue and full information from agent or direct from us.

International Harvester Company of America

INCORPORATED

CHICAGO, U. S. A.






OFFICES

BIRMINGHAM
BOSTON
BUFFALO
CHICAGO
CINCINNATI
DENVER
DULUTH
HAZLETON
HOUGHTON
HUNTINGTON
JOPLIN
KANSAS CITY
MEMPHIS
MEXICO CITY
NASHVILLE
NEW ORLEANS
NEW YORK
PHILADELPHIA
PITTSBURG, KAS.
PITTSBURGH, PA.
PORTLAND
SALT LAKE CITY
SAN FRANCISCO
SCRANTON
SEATTLE
SHREVEPORT
SPOKANE
SPRINGFIELD
ST. LOUIS
TERRE HAUTE

DU PONT "A"

BLASTING POWDER

is recommended for
blasting dimension
stone. It is remark-
ably even and regu-
lar in its action.

1802
1910

EXPLOSIVES



E. I. DU PONT DE NEMOURS POWDER CO., Wilmington, Del., U. S. A.

COPYRIGHTED BY E. I. DU PONT DE NEMOURS POWDER COMPANY, 1910

CHARLES F. MCKENNA, Ph. D.

Inspection of Cement

and all other Engineering Materials. Examination of Properties and of Economical Operation of Works.

**Consulting and General Practice in
Chemistry, Technology, Chemical
Engineering and Chemico-
Legal Cases.**

Long Distance Telephone.

Cable Address: PLAT PEARL

Laboratories: 221 Pearl St., New York City

Offices: 50 Church Street

Hotel Cumberland

NEW YORK

S.W. Cor. Broadway and 54th St.

Near 50th Street Subway Station and 53d Street Elevated

**HEADQUARTERS FOR THE CEMENT
AND MACHINERY MEN.**

New Modern Fire Proof

All Outside Rooms. No Carpets. All Oriental Rugs.

Transient Rates \$2.50 with Bath and up.

10 minutes walk to 20 theatres.

Send for Booklet.

HARRY P. SIMPSON, Formerly with Hotel Imperial

R. J. BINGHAM, Formerly with Hotel Woodward

SELECTED WHITE SAND

For.

Ornamental
Concrete
Stone



For.

Hard
Plaster
Finishing

Cement
Block

Facing

Exterior

Plastering

Stone & Marble Sawing

Shipped in paper lined box cars or 150 lb. bags

UNITED STATES SILICA CO.

1041 AMERICAN TRUST BLDG.

CHICAGO

Hess Furnaces



No. 45

"Leader" Hess
Steel Furnace

Price **\$49.00**

Delivered East of Omaha and
North of Ohio River
Pipes and Registers Extra

for the past 7 years, have been sent to customers in every state in the Union, freight prepaid,

On Approval

and the money held back till sixty winter days of actual trial have proved that all our claims for superiority have been fulfilled.

Isn't this worth looking into? Could we offer such liberal terms if we didn't know that the Hess Furnace excels in service, simplicity, efficiency, economy?

All we ask of you, if you need a furnace, is to investigate—to put your name on a postal card, mail to us and ask us for our booklet "Modern Furnace Heating." This booklet is an authority on furnace heating, and copies have been requested by many colleges, libraries, etc., for reference in engineering and mechanical courses. It instructs fully in the principles and practice of furnace heating, and should be in the hands of every builder and house owner. It is free on request.

In Buying Direct

From Our Factory You Pay Only One Profit—A Small, Factory Profit.

Our prices are not inflated with the usual cost for salesmen, branch stores, agents' and dealers' profits. The factory profit only, satisfies us, and you will be surprised at how much we can save you.

Special Heating Plan Free Before You Order

Let us have our experts prepare a special plan for heating your building. It will cost you nothing, and put you under no obligation to buy of us. Our thirty-six years of experience in designing heating equipments makes this free plan valuable to you.

Ask us more about it. A postal card today will serve the purpose.

Hess Warming & Ventilating Co.
919 Tacoma Bld., Chicago.

THIS POWERFUL AUTOMATIC BLOCK MACHINE

Makes 1000 Blocks 24"x12"x9" in 10 Hours.

Each block receives **20 TONS** "SQUEEZE" twice from opposite directions.

Ours is the only 1 piece, double air space, building block on the market.

WESTERN SHAW BLOCK CO.

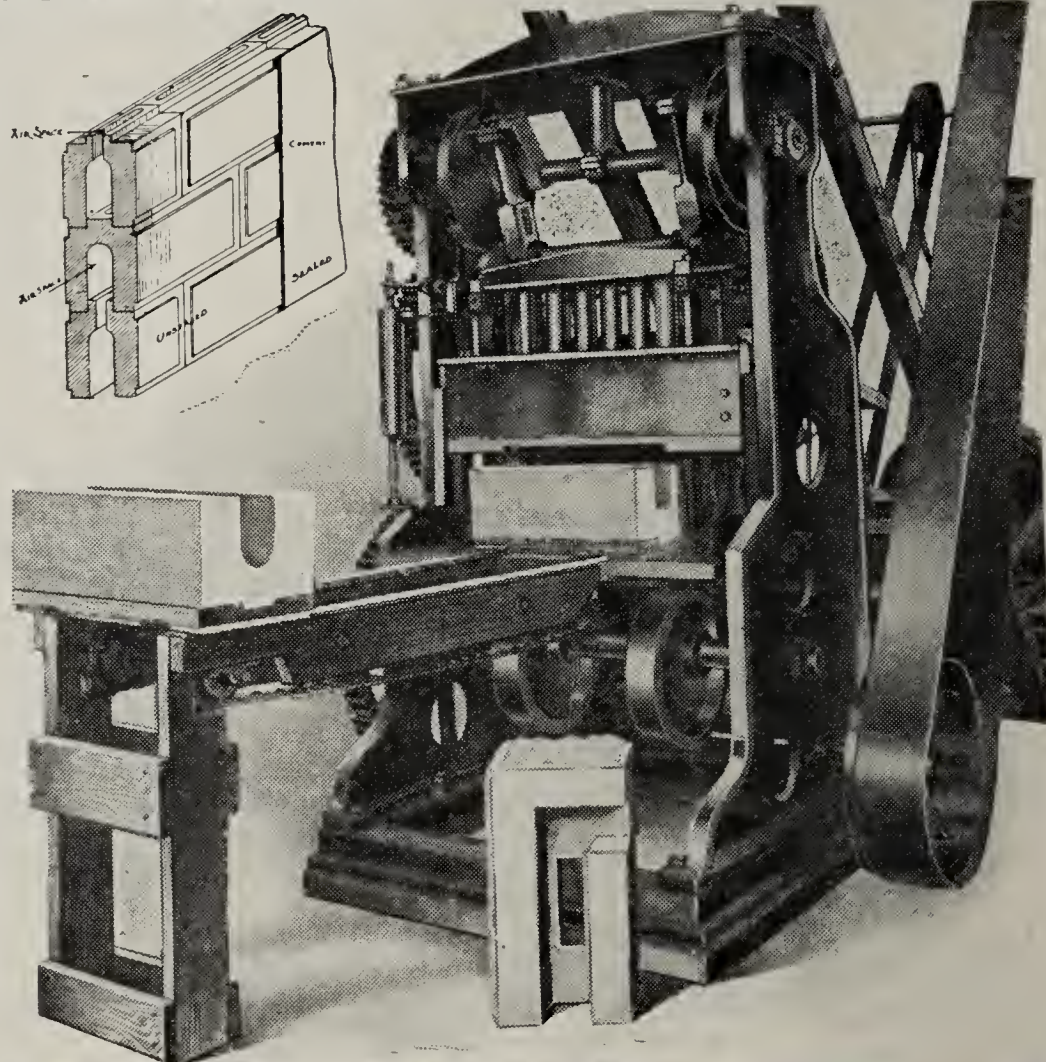
Room 317

218 LA SALLE ST., :: CHICAGO, ILL.

Our terms permit you to pay for the machine with a small per cent of your profits.

With this plant you can successfully compete with common brick, and be independent of the competition of any other building block machine.

Consult your own interest and get in on this live proposition.



When You Sit Down To Figure The Dollars Saved In A Concrete Mixer

IT'S not the first cost that's important but how soon the investment has been returned.

—There's the up-keep, the quantity produced, the quality of mixing and the saving in the pay roll when pay day comes.

—Quality in a mixer pays dividends when initial cost is forgotten.

But it costs just as much to build a mixer embodying the ideas in mixing of 5 or 10 years ago as it does the best mixing practice now.

Its not what you pay but what you buy that counts.

Here's an epitome of the fulfillment of present day mixing you buy in the

Koehring Concrete Mixer

The heaviest drum on any mixer—greatest strength in the most important wearing part.

Three independent, positive mixings in the one drum—most rapid mixer made.

Trunnion rollers placed close to ends to give drum great stability.

Rollers cast with broad faces and chilled as hard as tempered steel.

Double-gear drive close to ends equalizing uneven strains.

Charged direct from barrows on a level with the ground.

No elevated runways of any kind required.

Simplest charging elevator on any mixer.

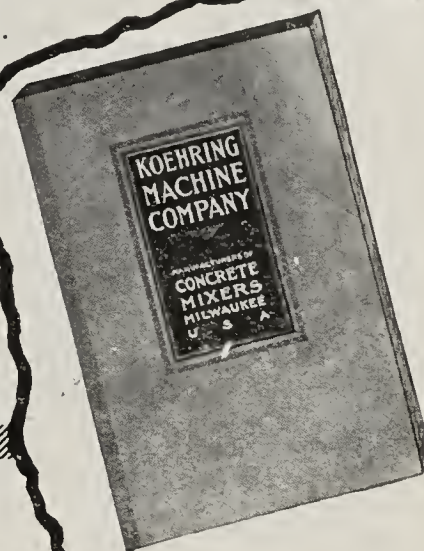
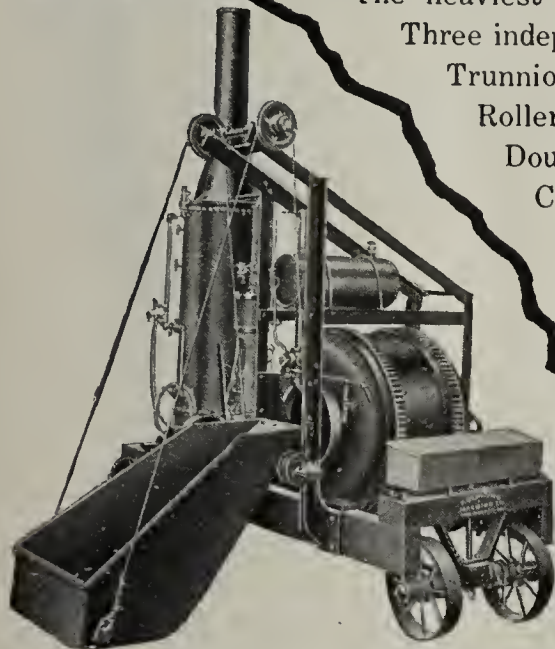
Discharge chute does not interfere with barrows.

Discharge always under perfect control.

Discharges by simply raising inner end of chute.

Equipped with steam, gasoline or electric power.

A card will fetch the catalog: mention "Catalog B."



Koehring Machine Co.

614-616 Germania Bldg., Milwaukee, Wis., U. S. A.



NONE JUST AS GOOD

THESE BOOKS are intended to be read by everyone who intends building. It makes no difference what you are going to build. you cannot afford to consider building without considering concrete as a building material. You cannot afford to consider concrete without knowing about

ATLAS PORTLAND CEMENT

BOOKS IN THE ATLAS CEMENT LIBRARY:

Concrete Construction about the Home and on the Farm	Free
Concrete Houses and Cottages, Vol. I—Large Houses	\$1.00
Vol. II—Small Houses	1.00
Concrete in Highway Construction	1.00
Reinforced Concrete in Factory Construction, delivery charge	.10
Concrete in Railroad Construction	1.00
Concrete Cottages	Free
Concrete Country Residences (out of print)	2.00
Concrete Garages	Free

Write for any or all of them to

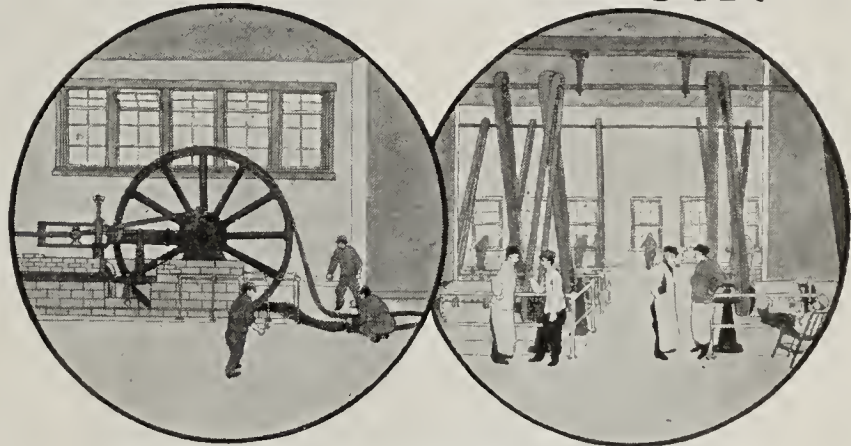
The **ATLAS** Portland **CEMENT** Co.

Dept. D, 30 Broad Street, New York

Largest output of any cement company in the world.

Over 50,000 barrels per day.

NOT THE NOON HOUR



REPAIRS ON THE MAIN DRIVE.

Perhaps this has happened in *your* plant? The belt-giving out. Machinery stops. Hands idle. But expenses run right along. Such mishaps can be avoided and highest efficiency permanently assured by using

RELIANCE Guaranteed Leather Belting

Repair Bills Reduced

For Tube, Ball, Griffin and Fuller Mills it is unsurpassable. Every Reliance Belt for cement work is protected by a special dressing.

Write for booklet.

Chicago Belting Company

12-22 Green St., Chicago

Branches: New Orleans, 431 Gravier St. New York, 71 Dey St.
Portland, Ore., 94 First St. Philadelphia, 234 N. Third St.



"Pioneer"

"Safest to use, because richest in Bitumen"

OUR asphaltic products were first introduced in 1896. For 14 years they have been undergoing the hard practical tests of every day use, and Engineers of repute in all parts of the United States are specifying "Pioneer" Asphalt materials today, because these materials have proven superior to all others.

Wherever there is a reservoir to be waterproofed specifications should be adopted which will prohibit the use of an inferior grade of asphalt. Wherever pipe line construction is in progress the question of *protection and preservation* of the pipe ought not to be decided upon mere claims, but the rigid demands of *specifications that are safe* should be enforced as a check upon lax methods and inferior materials.

"Pioneer" Reservoir Waterproofing Asphalt "Pioneer" Mineral Rubber Pipe Coating

Here are two commodities that will meet the demands of the specifications suggested. They are not experimental, but have both been used with the highest success for years, and under the severest conditions.

Over 99½% Pure

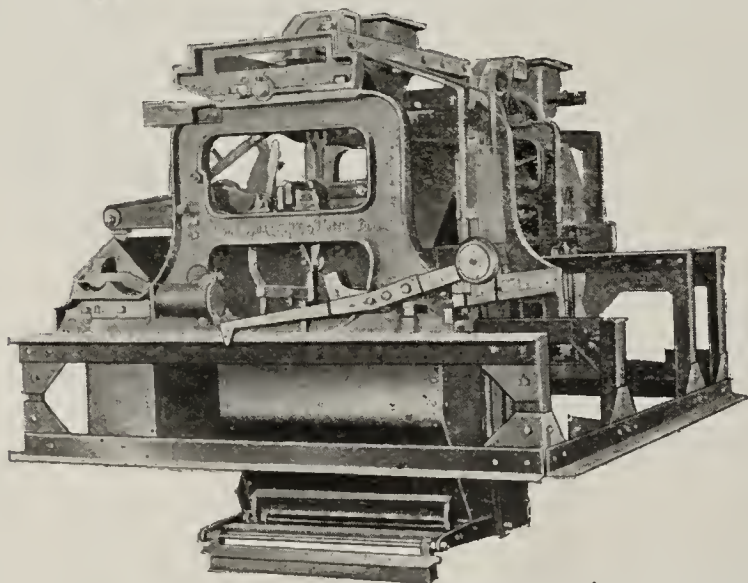
The superior quality of our asphalt is a *proved-out* proposition—a *known quantity*. Our own mines in Utah contain immense deposits of the purest hydro carbon known, our Gilsonite analyzing over 99½ per cent pure bitumen. In any true technical comparison of values "Pioneer" Mineral Rubber Pipe Coating and "Pioneer" Reservoir

Waterproofing Asphalt will readily demonstrate the superiority which has made them practically non-competitive. **Specifications** Send for our specifications and be safeguarded against those asphalt (which are offered as being equal to "Pioneer") the employment of which has, in spite of claims, proven them to be inefficient.

The American Asphaltum & Rubber Co.
600-614 Harvester Bldg.,
Chicago, Ill.

A
14
Year
Record
of Success

TO MAKE THE BEST CEMENT, USE Richardson's Automatic Proportioning Scales



Two or more scales yoked together with our Electric Discharge Mechanism will weigh Crushed Raw Materials direct from bins with perfect accuracy and discharge simultaneously.

These machines fitted with our Conveyor Feed will also weigh Pulverized Materials direct from bins.

Greatest Possible Range of Weights. Exact Proportions Absolutely Guaranteed. Continuous Uninterrupted Operation.

Similar Machines for Clinker and Gypsum. Automatic Hopper Scales for weighing Cement to Stock Bins. Automatic Bagging Scales for Finished Cement. Speedy and most accurate yet devised.

Write for particulars to

RICHARDSON SCALE COMPANY
16 Park Row, NEW YORK 122 Monroe St., CHICAGO

Cement Sewer Pipe Is the Large Profit End Of the Concrete Business



Miracle Cement Pipe Molds have been in general use throughout America and many foreign countries for the past five years, and are giving universal satisfaction. Within the past three months large plants have been equipped for the manufacture of cement pipe by the use of Miracle molds in the cities of Denver, Tacoma and Seattle, which cities have opened their specifications to the use of cement sewer pipe.

Special Sewer Pipe Catalog (Just Out.)
New Mixer Book (Just Out) Get one.
Sent FREE to readers of this Magazine.

MIRACLE PRESSED STONE CO.

Department "L."
MINNEAPOLIS, MINN.

CEMENT

... AND ...

ENGINEERING NEWS



Concrete Culverts.

Concrete culverts will soon replace all other kinds of culverts, because they are comparatively cheap and practically indestructible, while other culverts are but temporary and must soon be replaced. They are economical from the standpoint of the taxpayer, desirable on the part of the highway commissioner and profitable for the contractor. Miracle Pressed Stone Co., Minneapolis, Minn., are now making molds for building concrete culverts and have just issued a booklet concerning concrete culverts.

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue

Cable Address -- "Seaferts" Chicago.

Entered at the Post Office at Chicago, as Second-class matter, July 21, 1896
under Act of March 3d, 1879.

Subscription.	\$2.00 Per Year
Foreign Subscription.	\$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON	- - - - -	Advertising Manager
-----------------	-----------	---------------------

Chicago, June, 1910.

CEMENT PLANTS OPERATED BY BLAST FURNACE GAS.

The rapid pace at which the American cement industry is progressing calls for concentration of all our energy upon matters belonging to the present day and to the future, and hardly allows us to rest for a moment and to look back at the past. And yet, an occasional review of the history of the industry will be found to be both instructive and refreshing and is apt to encourage us to approach the problems to be solved in the future even with greater confidence and enthusiasm than in the past.

Mentioning the very beginning of the cement industry in this country is synonymous with calling attention to the development of the rotary kiln system of cement burning and to the arduous work of the men who invented and perfected this labor saving device.

The young industry flourished in the East at first, where it originated. Only gradually did it spread over the Middle West, where, here and there, a cement plant was erected in order to demonstrate to the builder that a high grade of Portland cement could be manufactured also in this country and that it was unnecessary to import cement any longer.

A number of favorable circumstances assisted in developing the industry, especially in some of the states, in which the manufacture of cement became in time one of the principal industries. Thus, the rapid development of the cement industry in the state of Kansas was made possible alone by its vast resources of natural gas, while, on the other hand, the state of Michigan became, for a number of years, one of the main producers of cement in the Middle West owing to its favorable location which afforded excellent shipping facilities to all industrial centers on the shores of the great lakes.

However, not in many instances was the development as swift and easy as in the case of the last named states. Most cement manufacturers had to establish a reputation for their brands and to grow gradually with the demand for the product in their territories.

The number of plants increased so rapidly in time, that superior shipping facilities to distant points was no benefit any longer, because there were cement factories everywhere. Therefore, from this time on, no unusual expansion of any concern occurred which could be traced to favorable location or special merits of its brand. The manufacture of cement had become a standard process and had settled down on a basis

of practical equality of all brands, which assured low prices to the consumer and a legitimate profit to the manufacturer.

The only district which, since this time, developed in an unexpected manner has been the immediate surroundings of Chicago. About ten years ago, three cement companies began to manufacture cement at La Salle, Ill. Outside of these plants, there was only one factory at South Chicago, using the slag of the Illinois Steel Co. in the manufacture of Portland cement. This was the whole extent of the industry in the state of Illinois. To-day the vicinity of Chicago is one of the greatest cement manufacturing centers of the World. How was this change brought about?—It was due to a process of development as laborious and far-reaching in its consequences as the change from the vertical kiln process to the rotary kiln system and required the industrious labor of a well-trained staff of engineers for many years. The work to be accomplished consisted in utilizing the waste gases of the blast furnaces of the Illinois Steel Co.

Many of our readers will remember the time when the first cement plant at South Chicago under the direction of Mr. Bergquist was the only cement factory in the immediate neighborhood of Chicago. To-day Mr. Bergquist is the proud superintendent of half a dozen cement plants designed by him, each of them several times larger than the first.

In the course of the past ten years, we witnessed the gradual growth of the Illinois Steel Co.'s cement plants, which, since a number of years, are managed under the name of Universal Portland Cement Co., and heard a great deal about the efforts required to perfect the process of cleaning the blast furnace gas so as to render it suitable for combustion in gas engines. However, on numerous former visits to the cement plants, we were merely shown the process of cement burning, from the granulated slag of the blast furnaces in connection with limestone, and were told that the electric current driving the machinery was generated by means of gas engines supplied with the purified blast furnace gas. But, not until a recent excursion to the cement plants at Buffington and to the steel works at Gary was our curiosity satisfied and was the first opportunity given to us to obtain some insight into the fascinating subject of utilizing the blast furnace gas in gas engines. We could see at a glance, from the complicated installation before us, that the task of preparing the gas for the engines could not have been an easy matter indeed.

The great difference existing between feeding natural gas to gas engines on the oil fields of Kansas and in supplying the same type of engines with blast furnace gas will become apparent, if we consider the origin and consumption of both kinds of gas. In one instance, nature supplies almost pure methane of high heating value (1000 B. T. U. per cubic foot) from subterranean reservoirs. This gas does not vary in composition and needs no purification; it is fed to the engines as it comes out of the ground. On the other hand, the waste gases of the blast furnaces vary in composition according to the kind of iron or steel produced and consist, under the most favorable circumstances, to one-third of combustible gas, namely carbon monoxide and hydrogen, and to two-thirds of inert gas, nitrogen and carbonic acid. The heating value of it amounts to about 100 B. T. U. per cubic foot. In addition to the variation in quality, it is subject to rapid changes in quantity, depending upon the number of furnaces in operation and upon the more or less smooth running of these furnaces. This, furthermore causes differences in temperature and pressure of the gas. All these factors have to be watched carefully; the gas has to be analyzed continu-

ously, the supply of it must be recorded and, by a number of ingenious devices, the whole installation had to be safeguarded. Otherwise imminent danger from explosion exists, whenever some of the furnaces cease to supply gas during casting time and cause air to be drawn in together with the gas by the suction in the pipe lines and if not at once some of the engines are taken off or the consumption of gas is reduced at some other point of the works. A disturbance likewise results, if the gas becomes too rich all of a sudden, which happens, if the charge slips in the furnace, thereby causing the wet raw materials to reach the zone of red heat too soon. In this event the gas is enriched with hydrogen and gives rise to premature explosions in the gas engines. The same happens, if leaks occur at water-jacketed valves and pipes leading into the furnaces; also in this case the water entering the incandescent zone of the furnace is decomposed into hydrogen and oxygen, thus changing the composition of the gas.

The points mentioned so far were anticipated at the time when the installation was conceived and consequently did not cause any unexpected expenditure nor create any surprise during the time of experimenting. It was simply a matter of providing sufficient storage capacity for gas and of training every engineer and chemist in charge of part of the installation to do his duty, so that ultimately everything went like clock work and the superintendent was able, from the reports received from the various departments, to give the necessary instructions with regard to the disposal to be made of the available gas supply and to changes in the operation of the plant.

A circumstance, however, which caused endless disappointment in the beginning of the experiments and which involved great expense of time and money was the fact that it was not believed, to be necessary to clean the gas to that degree of purity which experience ultimately proved to be indispensable. A superficial washing of the gas and removing of the bulk of the cinders and dust particles was thought to be sufficient. The first cost of installation and the operating expenses of the gas cleaning plant were, therefore, found to be much higher than expected.

In order to obtain an approximate idea of the work to be accomplished at this cleaning plant, it may be mentioned that the gas produced by a single blast furnace in the course of a year carries about 150 tons of flue dust, 99.5% of which have to be removed, if the gas engines shall be expected to run economically and without constant shut-downs.

At first only a washing plant was installed which made use of "static" methods, that is to say of stationary devices, consisting of flues, water seals, dust catchers and wet scrubbers, in which the dust particles settled either by gravity or after coming in contact with water in rain-chambers, towers in which a fine spray of water continuously moistened the dust-laden gas passing through it. The gas cleaned by these devices was found to be satisfactory for use under boilers and hot-blast stoves, but did not answer for gas engine purposes. It contained still 20% of its impurities.

Therefore, in addition to the former preliminary gas cleaning plant, a secondary plant had to be installed, in which the "dynamic" principle of washing was applied, that is to say in which the gas was brought in intimate contact with water in rotary washers. These latter, which had to be finally adopted after all other methods proved to be unsuccessful, are of the highest efficiency and leave practically only a trace of dust in the gas, not more in fact than the dust-laden air of the engine room contains, which, mixed with the gas, enters the cylinders of the engines.

We purposely confine ourselves to a few general remarks, as even a superficial description of the very interesting process of gas purification would lead too far. But we advise, every one, who had the good fortune of being a guest of the Universal Portland Cement Co. or of the Illinois Steel Co. during one of the numerous excursions of the past three months, to read at his leisure the "Operating Experiences With A Blast Furnace Gas Power Plant," by H. J. Freyn, an elaborate paper just published in the June issue of the Journal of the American Society of Mechanical Engineers. This paper will be found to be a valuable supplement to the information obtained at the Steel Works and will illustrate to the reader the mechanism of the many apparatus of enormous proportions required for the cleaning of the gas. The paper is profusely illustrated with photographs and sections of the machinery and contains a number of tables and charts showing the fluctuations in the composition and amount of gas.

A serious study of this subject can not but impress every thoughtful engineer with the magnitude of the work accomplished, which means another victorious struggle with physical forces and the recovery of an immense source of energy wasted so long.

FUSED PORTLAND CEMENT.

By C. Unger.

Translated by Dr. W. Michaelis, Jr.

(Continued from page 195)

Michaelis (in 1867) calculated from a great number of analyses of Portland cements the lowest and highest permissible percentages of the essential elements and obtained, by placing the silica and sesqui-oxides in opposition to calcium oxide, the values:

10 SiO_2 (R_2O_3), 20 CaO and

10 SiO_2 (R_2O_3), 24 CaO .

These formulae corresponded with actual practice, as cements containing less lime than indicated by the first formula disintegrated, while those surpassing the limit of lime given by the second invariably showed signs of blowing. From experiments of former investigators as well as from his own he concluded that calcium hydrate and silica were sufficient for the formation of a hydraulic cement; to this he gave, in conformity with Heldt the formula $5\text{CaO}, 3\text{SiO}_2 + 5\text{H}_2\text{O}$. Also from calcium hydrate and alumina he obtained compounds of excellent hydraulic properties. He discussed the views of his predecessors and declared himself in favor of Winkler by rejecting all theories which assumed calcined cements to contain large amounts of uncombined calcium oxide.

Erdmenger (in 1879) took the standpoint that Portland cement did not represent a well-defined mineral compound, but a silicate compound made soluble by fluxes. This flux, in his opinion, was the calcium oxide, and in accordance herewith he regarded cement as a "calcium waterglass" which was decomposed by water and in this state represented a mixture of substances, most of which were of a gelatinous nature. Owing to the great density of the undecomposed powder from which they originated, these gelatinous elements were forced to occupy an extra-ordinarily small space from the beginning and consequently could bring about a very effective cementation resisting all dissolving and disintegrating by the action of water.

From this simple enumeration of results obtained by investigators prior to Le Chatelier follows that the methods of investigation employed were not free of criticism, otherwise, there would not have been so many statements contradicting one another. All authors unanimously ascertained that by the burning process the formerly insoluble clay was converted into compounds soluble in acids, hence that chemical reactions took place between the various elements. But it was found impossible to follow the course of these reactions or to separate the different products which formed. The attempts at a determination of the various constituents by means of reagents must be considered as failures. Extraction of certain ingredients by water or aqueous solutions of salts must be positively declined. To this method Winkler took exception at first, after having demonstrated that water was able to continually extract calcium oxide from the cement. This opinion was supported by Michaelis and afterwards also by Le Chatelier and a great number of other investigators. Alone the ammonium nitrate dissolved in concentrated alcohol, as used by Winkler, may be permissible; but even in this case the proof is missing that silicates are not decomposed by this reagent.

It is not impossible, of course, that valuable results may be obtained with regard to the constitution of the calcined cement by starting out from hardened cement and working backwards, but in this case unusual precautions would have to be taken. It is no wonder, therefore, that the study of the composition of the hardened product has led to contradictory statements so far. Winkler, for instance, worked with hardened Portland cement. The difficulty to be encountered in a similar study lies in the impossibility to determine the time when the reactions underlying the hardening process are finished; not even the water of combination, which Feichtinger tried to determine, can be estimated with any degree of accuracy, as will be explained later. Heldt and Michaelis arrived at entirely different results. They produced artificially a hardened substance without being able to prove that this was identical with hardened cement. Besides, the method employed by Heldt corresponded by no means with the hardening process of cement. The same criticism applies to other hardened products artificially prepared by various experimenters.

The attempts at a reproduction of the active compounds in cement by synthesis likewise led to widely varying results and to complete failure as far as the proof was concerned that the desired "compounds" were actually obtained. The difference in the results was frequently due to neglect in examining the chemicals used as to their purity, a matter of great importance. The influence of different methods of investigation can best be seen from the fact that most investigators declare the aluminates to possess hydraulic properties, while Heldt states they do not harden at all.

The theories advanced for the explanation of the hardening process proper were based upon the constituents of the calcined cement which their authors believed to be the active parts. Michaelis, therefore, rightly said: "The hardening process can not be explained without having previously ascertained the constitution of the calcined cement."

For this reason the chief aim of the present publication shall be the "constitution of the calcined cement." As soon as this has been cleared up beyond doubt, the hardening will also be explained to every one's satisfaction.

Le Chatelier and Modern Researches: With Le

Chatelier begins a new era in the investigation of the constitution of cement. His experiments formed the basis for a long series of similar investigations by others.

Le Chatelier starts out "from the preconceived opinion that all phenomena are based upon mutual reactions between well-defined compounds, whereby other definite compounds are formed which, however, may be mixed in varying proportions."

His method of working means a step in the right direction in as much as he recognizes "that the various compounds of calcium oxide with silica and alumina must not only be studied from a chemical and mineralogical standpoint," but that it is also necessary "to prove their existence in the calcined cement."

At first he prepared by synthesis calcium silicates: CaO, SiO_2 corresponding with the mineral wollastonite, which latter, however, according to Bourgeois, crystallizes in a different system. The product, which was obtained by fusion, was only slightly acted upon by pure water; therefore, it was believed not to take a part in the hardening of cement; but in water containing carbonic acid it hardened well.

$2\text{CaO}, \text{SiO}_2$ disintegrated upon cooling. This phenomenon was not attributable to the atmosphere, because the calcined product acted in the same way, if placed under mercury immediately upon being fused. Also decomposition did not take place, otherwise free calcium oxide would have been present. Le Chatelier finally explained this phenomenon by the dimorphism of the di-calcium silicate. In an atmosphere free of carbonic acid, it did not set even after 6 months and was consequently supposed to take a minor part, if any, in the hardening of cement.

The preparation of these fused mixtures of calcium oxide and silica, however, did not satisfy Le Chatelier. From numerous analyses of cements he drew the conclusion that a tri-calcium silicate existed and, in his opinion, prepared it in a round-about way. To this I shall come back in one of the following chapters.

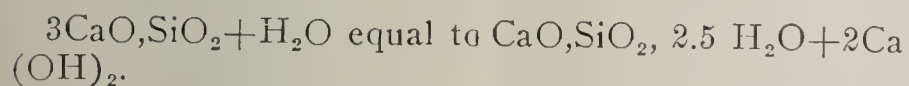
With regard to the aluminates he corroborated the statements made by Frey. He found three aluminates: $\text{CaO}, \text{Al}_2\text{O}_3$; $2\text{CaO}, \text{Al}_2\text{O}_3$ and $3\text{CaO}, \text{Al}_2\text{O}_3$, which set very rapidly under development of heat, and which showed increasing signs of blowing with the growing of the contents of calcium oxide.

Yet, the most important innovation introduced by Le Chatelier was the microscopic research of cement. Winkler had used the microscope before him, to be true, but only in a very superficial way. Le Chatelier recognized in calcined cement four different crystallized "minerals" and an amorphous substance, two of which will occupy our main interest, namely 1. Colorless pseudocubic crystals possessing slight double-refraction, and 2. A colored fused substance, strong double-refracting, filling out the interstices. Treatment with diluted acids and weak ammonia water revealed that No. 1. took the main part in the hardening process. This mineral was not fused, but was precipitated from the fused mineral No. 2. The fused mass contained the bulk of the iron as Fe_2O_3 , while the lower iron oxide could rarely be found in cement. Separation of these two minerals was found to be impossible, although Le Chatelier reduced the iron oxide of the fused substance by means of hydrogen and tried to separate this mineral from No. 1 by a magnet. Also elutriation by means of mercury iodide failed. Therefore, he looked for a material which contained only one of the two minerals. He found the desired cement in the "grappiers," the hard-burnt parts contained in hydraulic lime, which remain intact

after the slaking process, and which, in France, have been used for some time in the cement manufacture. These grappiers contain, in addition to substances as CaCO_3 , CaO , Ca(OH)_2 and CaO, SiO_2 , hard grains showing a crystalline structure upon breaking. Microscopic examination revealed these grains to consist almost exclusively of the crystals which were discerned as the main part of Portland cement. The average figures of the main elements taken from four analyses were the following:

SiO_2	CaO	Al_2O_3
25.4%	67.3%	3.2%

The analysis contained for 1 mol. of SiO_2 2.85 mol. of CaO . From this Le Chatelier concluded that the main constituent of Portland cement was a calcium silicate differing only slightly from the formula 3CaO, SiO_2 . This is the cardinal point in Le Chatelier's researches. His theory of the hardening process is based upon this tri-calcium silicate from which, in his opinion, derives the only hydrated calcium silicate he was able to produce. He formulates the change taking place upon addition of water as follows:



By the use of the same method, **Toernebohm** (in 1897) arrived at somewhat different results. A comparison of both publications will show the best what caused these differences. Microscopic examination revealed in his case the same "minerals," which he designated as "alite," "belite," "celite" and "felite," and a "glassy residue." These names have been found very convenient and have been used so much since, that it is advisable to retain them. The minerals referred to in the foregoing as the most important are represented by alite and celite. Toernebohm describes alite as belonging to the rhombic system, but possessing hexagonal habitus. His description of the minerals is more complete than that by Le Chatelier and coincides with his very well. In order to arrive at the chemical composition of the constituents, Toernebohm made a series of experimental burnings in which he added to a "standard mixture" a few per cent of different substances for the purpose of observing their influence upon the crystals to be formed. A clinker, composed of "standard mixture" plus 4% CaCO_3 , contained almost exclusively alite and celite.

He objected to Le Chatelier's theory in as much as he did not assume a tri-calcium silicate to be present in cement, though he did not consider it infeasible that such a compound existed. The non-existence of a tri-calcium silicate in cement followed, in his opinion, alone from the low percentage of silica in a normal Portland cement clinker. While 26% of SiO_2 is the maximum ever found in a clinker, all of the compounds, by Le Chatelier supposed to be contained in it, contain more than 26% SiO_2 . The assumption, that free calcium oxide were present, never occurred to him nor to Le Chatelier. The statement, which the latter made afterwards, that a tri-calcium aluminate ($3\text{CaO, Al}_2\text{O}_3$) existed in cement clinker was likewise refuted by Toernebohm, because this could not have escaped detection under the microscope.

This last assumption by Le Chatelier contradicts his own micro-chemical researches by which had been proven that all essential constituents of calcined Portland cement contained silica. Moreover, the four analyses of grappiers which induced Le Chatelier to assume a compound 3CaO, SiO_2 contained on an average 3.2% Al_2O_3 which, as will be proven later, were not allowed to be regarded as mere adulteration.

These well-justified objections led to the conclusion that also alite must contain alumina, and Toernebohm wished to prove this by analysis. He separated the alite by elutriation with methylene iodide and, although he had to admit that the separation was not quite satisfactory, he made two analyses and figured out the following composition for alite (whereby he arbitrarily assumed that his product was adulterated only by 10% of celite, while the latter, moreover, was supposed to contain all the iron):

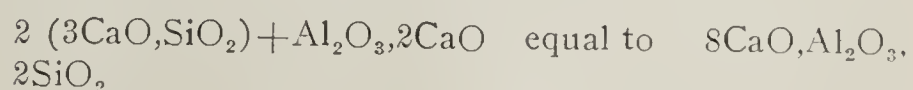
SiO_2	19.48%
Al_2O_3	7.83%
CaO	67.60%
MgO	3.00%
Na_2O	0.90%
K_2O	1.19%

These microscopical researches have been repeated by **Hauenschield**, **Feret**, **A. Mayer**, **Richardson** and others and have been confirmed by them. With their aid all future observers tried to explain the constitution of cement clinker. In many instances, much guess-work has been done, of course, without advancing the knowledge on the subject. Especially all attempts at an explanation by means of complicated formulae for these "minerals of hypothetical composition" must be declared futile.

Of the numerous publications on the subject that appeared since Le Chatelier's and Toernebohm's fundamental work in this line, only some remarks by Richardson shall be mentioned who regards Portland cement as a "solid solution." He writes:

"Unfortunately no attempts have been made to prepare in a synthetic way the following three kinds of clinker and to examine their optic properties: 1. Clinker consisting of pure chemicals. 2. Clinker containing, in addition to silicates and aluminates, 'double-compounds' supposed to be present in cement. 3. Clinker containing the same ingredients in varying proportions."

Along these lines his experiments were conducted. He found di-calcium silicate and "tri-calcium silicate" to be crystalline and to possess characteristic optic properties, which will be dealt with in the next chapter. The result of the preparation of "double compounds" assumed by other investigators was that none of these corresponded in the least with any of the constituents of Portland cement, neither in structure nor in its optic properties. A singular homogeneous structure presented a product of the following composition:



As he could not distinguish the silicate from the aluminate, even upon powerful magnification, and was unable to discern a proof for fusion having taken place, he considered the constituents of Portland cement to be "solid solutions." Also other experiments proved that silica, alumina and calcium oxide were soluble in widely differing proportions, providing the mixture contained a sufficient amount of calcium oxide. His work is incomplete so far; definite results, therefore, can be expected only after his experiments are finished.

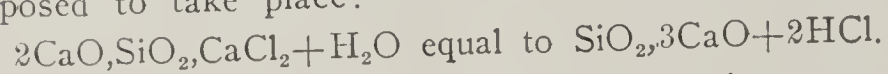
The Tri-Calcium Silicate: Since Le Chatelier the term "tri-calcium silicate," 3 CaO, SiO_2 , has widely been used in the cement literature, and there are chemists even nowadays who still consider it to be the active part of Portland cement. Men of science, however, have never believed in a similar "compound." Kanter, for instance writes: "Thus the opinion could prevail for years that a 'tri-calcium

silicate" existed in Portland cement, an assumption now definitely discarded."

A survey of the literature dealing with tri-calcium silicate exhibits the most contradictory views. It would lead too far to describe all publications on this subject in detail. Opponents to this theory are, of course, all investigators assuming a large amount of free lime to be present in cement, but also others as Toernebohm and Rebuffat. But even the advocates of tri-calcium silicate do not agree among themselves.

Le Chatelier was the first who tried to obtain a tri-calcium silicate by synthesis. However, he did not succeed as long as he merely used silica and calcium oxide; this mixture invariably resulted in a powder which contained free calcium oxide and which slaked in the same way as burnt lime upon mixing with water. If he employed calcium chloride as a flux and extracted subsequently with alcohol, he obtained a crystallized calcium-chloro-silicate of the composition $2\text{CaO}, \text{SiO}_2, \text{CaCl}_2$.

This he treated with steam of a temperature of 450 centigrade, whereby the following reaction was supposed to take place:



After frequent repetition of this process he secured a product of the following composition:

	Found.	Estimated for $3\text{CaO}, \text{SiO}_2$.
SiO_2	26.7%	26. %
CaO	72.1%	73.7%
CaCl_2	1.2%	

However, he had no right to consider this as a tri-calcium silicate, so much the more as the physical properties did not correspond with it. The powdered substance did not show a trace of crystallization and hardened only after 8 days in boiling water. Le Chatelier himself was not quite convinced that this product was a well-defined compound.

Oddo (in 1896) fused a number of silicate mixtures in an electric furnace. He formed prisms of the raw mixtures which were piled up in a way that permitted him to avoid graphite crucibles that would have spoiled his products with calcium carbide.

His experiments with CaO, SiO_2 and $2\text{CaO}, \text{SiO}_2$ gave the same results as Le Chatelier's did. The mixture $3\text{CaO}, \text{SiO}_2$, however, could be fused completely only at the hottest place of the electric arc-light. The mixture was taken out of the furnace in a red hot state and immediately placed in a dessiccator. Notwithstanding this precaution, the whole mass crumbled into fine dust with the exception of a few small pieces of porcelain-like appearance.

Analysis revealed the disintegrated part to consist of a mixture of 1 mol. CaO plus 1 mol. $2\text{CaO}, \text{SiO}_2$, while the porcelain-like particles had the following composition:

CaO	78.72%
SiO_2	21.28%

Neither substance hardened with water. With hydrochloric acid both of them yielded gelatinous silica.

Upon further increase of calcium oxide in the mixtures subjected to fusion, the final products slaked and developed heat in contact with water.

Oddo concluded from these experiments, "that silica, in the presence of a surplus of calcium oxide, combined with it only to the extent of forming di-calcium silicate ($2\text{CaO}, \text{SiO}_2$), while the remaining calcium oxide retained its capacity to slake with water."

These experiments carried on by Oddo made every one seriously doubt the existence of a tri-calcium silicate. However, his results, especially the composition of his products, were considered to be not sufficiently reliable to permit of so broad a statement. The results of his experiments, which have since been proven to be true through the researches by Day and Shepherd, were contradicted by Newberry who, surprisingly, found ready believers. This latter experimenter aimed, in the first place, to answer questions of paramount importance to the practical cement manufacturer. Thus he advanced a formula for the calculation of the proper composition of Portland cement from its raw materials, which, as "American formula" has been placed in opposition to the "hydraulic modulus" of Michaelis giving the most favorable ratio between bases and acids in cement.

The mixtures for the synthetic experiments prepared with almost pure materials (quartz containing 99.10% SiO_2 , calcium carbonate 99.7% CaCO_3) "were intimately mixed, moistened with water, placed in a Fletcher gas furnace and burnt in immediate contact with the flames."

All preparations proved to be sound after having been exposed to steam of a temperature of 98 centigrade for 4 or 5 hours. From this was concluded that no uncombined calcium oxide was present.

The product which resulted from the mixture corresponding to the formula $3\text{CaO}, \text{SiO}_2$ was only slightly vitrified; it did not develop heat upon mixing with water and hardened very little in 1 day; after 7 days it was still quite soft, but was found to be hard after 6 weeks. Consequently it acted more like hydraulic lime than like Portland cement. On the other hand, a product which contained only 2% Al_2O_3 possessed the properties of a high grade of Portland cement. This latter point is of the greatest importance, for, whenever no accurate analyses are given by investigators an adulteration of a small percentage of alumina must be expected to be present, which makes a great difference in the results obtained.

These experiments were continued by Newberry and Smith and led to additional information about the "tri-calcium silicate." In the first place, the former experiments with sintered $3\text{CaO}, \text{SiO}_2$ were repeated. The materials employed were comparatively pure; nevertheless, their product contained 0.88% Al_2O_3 and showed imperfect hardening. Quite differently, however, behaved a product fused by an oxygen-hydrogen flame after the method first employed by Michaelis. This set slowly in water and hardened as well as the best Portland cement. Microscopic examination had the following result: "The fused tri-calcium silicate consists of a double-refracting material with rectangular cleavage and with an extinction angle between crossed nichols parallel to the cleavage cracks." Interference colors were not obtainable. This product was evidently not identical with the crystals observed by Le Chatelier.

Also Rebuffat tried to obtain "tri-calcium silicate"; however, he did not succeed in fusing this mixture at the melting temperature of platinum. Newberry's success in doing so he attributed to an absorption of sodium oxide from the lining of the furnace. But, even with the aid of an oxy-hydrogen flame he obtained only an adulterated product; it may be, that his raw mixture was not as well prepared as that of Newberry. Subsequent investigations compelled him to declare that a "tri-calcium silicate" did not exist.

(To be continued)

IRON-ORE CEMENT.

The French engineer E. Maynard read at a recent meeting of the French branch of the International Society for Testing Materials a paper, covering his experience with iron-ore cement manufactured under the patents of the firm of Fried. Krupp, from which we abstract the following:

The test pieces were subjected to a rigorous chemical examination after having been kept in sea-water (Atlantic Ocean) up to more than five years.

The neat iron-ore cement was mixed with 22.5% of distilled water and placed in sea-water as soon as set. Its composition was found to be immediately upon being taken out of the sea-water:

A. Neat Cement plus 22.5% distilled water. Kept in Sea-Water :

	1 Day	1 Mon.	3 Mon.	6 Mon.	1 Year	5½ Years
Loss up to 100 Cel.	15.35	11.34	12.51	13.81	12.70	11.73
Loss from 100 C. to red heat	none	0.36	5.64	5.90	4.47	4.37
Water						
Carbonic Acid						
Silica	16.92	17.95	17.93	18.09	18.24	18.80
Alumina	4.29	4.03	3.93	3.96	4.05	4.22
Iron Oxide	5.01	5.09	4.98	4.99	5.04	5.15
Calcium Oxide	44.26	45.57	46.45	45.67	46.00	46.50
Magnesia	0.29	0.31	0.40	0.36	0.40	0.42
Sulphuric Acid	1.12	0.52	0.50	0.48	0.46	0.44
Sodium Chloride	0.14	1.06	1.06	1.13	1.21	1.28
Undetermined	0.35	0.17	0.22	1.12	0.11	0.11
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Free Lime determined with glycerine	6.45%	7.20%	8.05%	8.35%	7.61%	10.36%

B. 1 Cement, 3 Sand plus 0.585 distilled water. Kept in Sea-Water :

Loss up to 100 Cel.	8.54	6.14	7.41	7.79	7.35	8.35
Loss from 100 C. to red heat	none	0.53	3.03	3.42	3.38	3.86
Water						
Carbonic Acid						
Silica	9.51	9.38	8.91	9.17	9.25	8.69
Alumina	1.99	2.37	2.58	2.53	2.53	2.30
Iron Oxide	2.67	2.79	2.95	2.99	3.06	2.90
Calcium Oxide	12.80	14.1	13.61	13.46	13.62	13.42
Magnesia	0.27	0.33	0.40	0.39	0.37	0.40
Sulphuric Acid	0.65	0.58	0.78	0.80	0.82	0.78
Sodium Chloride	0.21	0.59	0.59	0.60	0.65	0.58
Sand and Clay	58.07	57.75	56.57	56.57	56.98	56.50
Undetermined	0.17	0.30	0.29	0.27	0.19	0.12
	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Free Lime determined with glycerine	3.20%	5.26%	6.11%	6.17%	6.42%	3.80%

From these analyses Maynard draws the following conclusions:

1. That the loss between 0 centigrade and 100 centigrade, which represents the porosity of the mortar, varies little.

2. That the same applies to the loss between 100 centigrade and red heat, which indicates remarkable stability of the absolute volume of the ingredients of the cement.

3. That, practically speaking, no lime and silica have been extracted, which denotes high resistance to sea-water.

4. That the percentage of magnesia, calcium sulphate and sodium chloride varied little during the time

Thus, iron-ore cement shows an excellent behavior towards sea-water, which must be attributed principally to its density. (The specific gravity of iron-ore cement is even higher than that of ordinary Portland cement.)

The author concludes his paper by expressing the hope that iron-ore cement will be used freely for marine construction in the future, or that at least ordinary Portland cements be used for this purpose which are low in lime (not higher than 1.7 parts of calcium oxide to 1 part of silica plus alumina plus iron oxide) and which likewise possess greater resistance to sea-water than the commercial high-limed Portland cements.

THE PREPARATION OF CONCRETE: FROM SELECTION OF MATERIALS TO FINAL DISPOSITION.

By Harry Franklin Porter, C. E.

The preparation of concrete is an art requiring every bit as much exact knowledge, experience, skill, and painstakingness as the preparation of steel. It is, if anything, a more difficult art than steel making; for while the latter is carried on under fixed conditions and everything favors reduction of the process to a science, the preparation of concrete seldom takes place under conditions twice alike. In the first place, the materials themselves vary greatly, from place to place, and from time to time, differing in composition, quality, size, and grading; and in the second place, the assembly of the various materials that go to make up the composition of concrete, and their final deposition as concrete, involves a continual readjustment of the *modus operandi*. To prepare concrete properly, therefore, it becomes very necessary—

(1). To make a careful investigation of available materials before each and every use, involving an analysis to determine fitness, and a synthesis to fix upon proper proportions to insure the desired results; and,

(2). To see that every reasonable precaution is taken, in the several operations incidental to installation, to insure proper handling of the materials, both before, during, and after intermingling, until the finished product is in place; and thereafter to see that it is left to solidify under the most favorable conditions possible.

In order to undertake successfully—and successfully means intelligently—the preparation of concrete, it is of course first necessary to understand the principles involved.

It may be stated as the chief aim of concrete preparation to secure as dense and homogeneous a mass possible, by which it is meant that there shall be the closest possible contact between particles, and that the particles shall be so sized as to reduce the contained voids to a minimum.

To secure a dense concrete two things are necessary:

(1). To effect, by the manner of sizing and proportioning the inerts, a maximum reduction of voids; and

(2). To fill all pores, interstices or voids remaining after the reduction as above with an elastic, insoluble and tenacious substance, which must first have the property of a liquid, so as to flow freely into place, secondly that of a glue, to unite all particles into a homogeneous whole, and thirdly that of becoming itself hard and stone-like.

It is not possible, no matter how carefully and to what extent the grading of inerts is carried, to thereby alone eliminate virtually all voids, any more than it is possible, in the familiar illustration in geometry, to divide a rectangle until there shall be no more to divide. Various inerts, as they come for use in concrete mixtures, have voids roughly as follows: Broken stone, one size, 50 per cent; broken stone, two sizes, not greatly differing, 45 per cent; gravel, one size, 50 per cent; gravel of indiscriminate sizes as found naturally, 30 to 40 per cent; natural sands, 30 to 40 per cent; artificial (crushed stone) sands, 35 to 45. Thus on the average, inerts—as they come naturally to hand—have from one-third to one-half of their volume air-space, or voids. Ordinarily, by combining broken stone or gravel with sand, in certain proportions, usually about two volumes of the former to one

of the latter, it is aimed to reduce these voids, not entirely or even as much as possible or advisable, but only somewhat. This "somewhat" may reach as low as 15 per cent, if haply the finer inerts—the sand—are particularly well graded naturally; more often it is not less than 25 or 30 per cent. The balance, whatever it may be, is then offset, as best may be, with cement. A typical specification for such a mixture would read:

"The voids in the coarse aggregate are to be filled by an equivalent volume of fine aggregate, and enough cement is to be supplied to fill the voids in the fine aggregate with (say) 10 per cent, excess."

Or it might be stated more simply and specifically yet:

"The concrete is to be proportioned one part by volume of cement, to two parts sand, to four parts broken stone."

Of these two specifications, both of which are typical of average practice, the former is the more scientific; but neither is scientific enough to insure consistently good results, the object, presumably, we are after. In the first place, statement of the proportion of cement by volume measurement is exceedingly slipshod, for it ignores the fact that cement dry from the bag, cement packed down, and cement mixed with water, have volumes respectively that differ widely, and that it is the volume of cement with its requisite water that should be taken into consideration; secondly, that there is no accurate or real distinction between coarse aggregates and fine; and thirdly, that actual voids in aggregates is a very variable quantity, differing practically, not only with every job, but from day to day on the same job, even from hour to hour.

It is some improvement to state the proportions, as many engineers are now doing, as one part cement to so many parts aggregate, making no longer a distinction between fine and coarse aggregates. But this even is not enough. A specification to be proper should state, first, the **maximum size** of inerts allowable; second, the **maximum voids**; and third, the **quantity of cement paste** necessary to effect a final filling of the voids and fulfill the requirement of a binder for all particles.

The maximum size of inert, that figures in the mixing of the concrete proper, is fixed usually by the conditions of practice; it is of advantage to have it as large as practical, since the larger the individual volume of the inerts the less, relatively, the superficial surface to be coated with binder. This follows from the fact that, whereas the volume of solids increase as the cube of the diameter, the surface increases only as the square. Three conditions, at least, work to limit the maximum size inerts:

(1). The incorporability: no particles should be used in the mix proper that will not readily merge with it.

(2). The width of the members that are to be cast.

(3). The location and spacing of the reinforcement.

By the first consideration the size is limited to about two inches; and by the other two on occasion, to as fine as $\frac{1}{4}$ -inch, and seldom, in reinforced work is larger than $\frac{3}{4}$ -inch practicable. Two-inch stone, even, are not easy to mix, and it is probable, for the best mixing, not larger than 1-inch to $1\frac{1}{2}$ -inch should be used. Other grades of inerts are then to be supplied of such sizes and amounts as to effect a maximum reduction of voids. It is entirely possible to reduce the voids to 10 per cent and even less; but probably 10 per cent is a practical minimum. To fill the remaining voids cement must be largely relied upon.

Not many sizes of inerts are needed. Suppose the maximum is fixed at one-inch; then, as it has been found experimentally and as it may be demonstrated

analytically, the next size smaller should be, in order to fit easily into the voids of the maximum size, approximately one-fourth as large, that is, in this case, $\frac{1}{4}$ -inch, and there should be about half as much of them; the next size should be approximately one-quarter of the second—viz. $\frac{1}{16}$ -inch, and a volume of them equal to one-half of the second size or one-fourth the first, and so on, down to impalpable dust; but probably there will not be more than four or five grades altogether, the finest grade comparing with cement in fineness, finer than which it is scarcely possible to go. This law of grading, if represented by a curve, would assume the form of a parabola, having its origin at the intersection of zero size and zero proportion, and approaching coincidence with the horizontal at the intersection of the 100 per cent ordinate and the maximum size abscissa. It will be found of this parabola, that the intersection of the 50 per cent ordinate and one-fourth the maximum size abscissa, and the intersection of the 25 per cent and the $\frac{1}{16}$ th size, and so on as outlined above, will fall in it or near it.

By use of such a curve, and the separation of a combination of inerts proposed for use into several grades down to dust, plotting the results alongside the standard curve for comparison, the deficiencies can be at once recognized when the extra proportion of any one or more sizes, or the proportion of a size not present, may be readily calculated, and the deficiencies corrected.

If there is an excess of coarse stuff the curve will be too flat; if an excess of fine, too high. An excess of fine is particularly objectionable in that it crowds the cement grains and prevents their working properly; moreover, it requires an excess of cement, over and above a properly graded aggregate. An excess of cement is also required where there is an excess of coarse stuff; but, unlike the other condition, there is no crowding of the grains; the cement still does not function properly, in that it is congested in the large voids instead of being distributed in thin films and fine points, forming as it were an interlacing meshwork, entwining all particles, but this condition is not so bad as the former.

Best results obtain when the grading is uniform, from maximum to dust, but with no more than 10 per cent of the finest grade, which approximates the cement in size and may be regarded as replacing so much of it as finest filler. The cement, then, when made into a fluid with water, will have only to coat all particles with a thin film and to bridge a few small remaining interstices. Nothing but a liquid can perform this office; this is an important point and will be dwelt upon hereinafter.

Another point: It is well not to have the sizes to close together, as for instance, to have a mixture of 1-inch and $\frac{3}{4}$ -inch stone, for the reason that $\frac{3}{4}$ -inch will crowd the inch, preventing it from assuming the most compact form; in fact, even so large as $\frac{1}{2}$ -inch will crowd the larger size. The desideratum is (1) that the maximum size should be free to assume its most stable configuration, which is when all particles are in as close contact as possible; and (2) that the next smaller size should just be large enough to neatly fill the maximum interstices, and that there should be just enough of this size to fill all these interstices. Similarly, the next smaller size should be such in dimension and amount as to effect a complete filling of the next largest interstices, and so on.

If this law of grading is observed, it will be found that the final total volume about equals the original volume of the maximum size, and that mixture will be the most dense of which this is the nearest true.

This points a practical way to determine upon the

best proportions—to-wit, to try a number of different combinations of the materials available, and to use that one which gives the least volume, or the one nearest the size of the volume of the maximum size particles alone.

Needless to state, almost, the test mixture should be so soft as to quake like jelly, and be ready to flow, for the above indications as to quality to be apparent. Similarly, during the deposition of concrete, if it is of a proper liquid or semi-liquid consistency, the trained eye of the foreman or supervisor can keep track of the quality of the mixture almost as accurately as an automatic proportioner, supposing there were such an instrument. As a matter of fact, there is no satisfactory substitute for the trained eye of the installer, nothing that can detect so quickly and accurately any variations in the composition of the mixture, as occur often many times in a single day on the average concrete job, due sometimes to variations in the material, again to mistakes of the workmen.

Another way to gauge the accuracy and sufficiency of the grading is by weighing. That mixture, obviously, which weighs the most relatively is the densest. If the solidity of the concrete were absolute, that is, if the voids were completely filled, its weight would be in the neighborhood of 165 pounds per cubic foot, if the inerts were of quartz, 170 pounds if of limestone, and 180 if of trap. A quartz concrete, thus, that weighed close to 160 pounds, would be about as dense as it would be possible to make it. A few pounds, always, are to be allowed for shrinkage, say two per cubic foot for moderately wet mixtures, so that if measurement and weight are taken wet, this correction should be applied before estimating the density. There will be no less, too, by evaporation, to take into account, if the concrete is to be allowed to harden freely exposed to the air. If wet-blanketed, then there will be practically no loss from this source. A weight of 160 pounds for a quartz-concrete, hardened under favorable conditions of wetness, with shrinkage allowed for, can scarcely be improved upon. It means a solidity of 87 per cent, or a reduction of voids to three per cent. A concrete this dense will be found practically impervious to water, even under considerable head, indeed to the limit of its strength. What more could be asked?

The size of inerts is not necessarily limited to the maximum stated; if conditions permit as large stone as it is convenient to handle may be intermingled with the mass, so long as there is always an abundance of concrete—which in this case may be regarded as a coarse mortar—to completely cover them. Such stones may be called, to distinguish them from ordinary inerts, **bulk-swellers**.

Bulk-swellers should not be less than four diameters larger than the largest inert, and preferably still larger, in order that there may be no doubt as to the fine material slipping into the voids, in case especially if the volume of bulk-swellers is sufficient to cause the concrete-proper to occupy the relation to the void-filler; but they should in no event be less than four times larger, lest they act merely to displace or crowd the coarsest inerts, rather than an equivalent volume of all inerts. If the bulk-swellers are so sized, a volume of them may be used equal approximately to twice the volume of the concrete-proper. Of course, practically, bulk-swellers being generally added subsequently and individually, relative volumetric considerations scarcely figure, but—as stated previously—coarser particles may be added up to the point where there ceases to be a sufficiency of fine material to thoroughly imbed them.

When large stone are introduced into the mass,

great care must be exercised to see that they are well distributed, with a comfortable margin of soft material all around, above and below each piece. The danger is, of course, that the large stone, particularly if regular in shape, will bunch, either across or up and down, introducing thus planes of weakness. It is also important that the stone be clean and thoroughly wetted, lest the adhesion be deficient.

The shape of bulk-swellers is an important consideration likewise; cubical or square-faced blocks are less desirable than irregular or well-rounded ones, for square edges act like so many wedges, tending to cleave the mass as in hardening it shrinks around them. Rounded stone, on the other hand, imbed themselves more naturally, the mass in shrinking tending to conform to their contour; irregular shapes tend to key themselves in, and to prevent, rather than induce, cracking. Flat stones are less desirable even than cubical ones, as their tendency to induce splitting is still more pronounced. These objections on the score of shape constitute in fact the greatest drawback to the use of large bulk-swellers.

An interesting example of the use of large bulk-swellers is afforded in the construction of the piers and abutments for the new concrete arch bridge across the Rocky river at Cleveland, which outranks the famous Walnut Lane bridge spanning the Wissahickon in Fairmont park, Philadelphia, both in span and in height. In this instance huge chunks of rock, as large as could be swung into place with a derrick, were introduced into the mass at frequent intervals, being first cleaned, dusted and wetted. Advantage was taken of these stone, at the conclusion of any period of operation, when there was to be a break of some little duration, by placing them so that about half protruded, thus providing an admirable key for the subsequent work. It is an interesting fact that, although frequently square-faced stone were used, no unfavorable shrinkage action showed itself; which would indicate that most of the shrinkage must take place while the concrete is still plastic enough to conform to the rigid outline of the contained block without separating. Hence the tendency to induce cracks, as pointed out before, may not be so serious a matter as offhand might be supposed.

There is another advantage in the use of bulk-swellers, of irregular shapes especially, rounded ones less so, namely, that they act also as reinforcement, forming here and there, throughout the mass, so many rigid keys locking the parts together, and in this way enhancing, no doubt, both the compressive and tensile strength—if not very much in the long run—at least an appreciable amount on short time. Of course, just how much strength will be added in this manner depends largely on the character of the stone itself. This enforces the necessity for a good quality of stone, always, for concrete mixtures.

Bearing on this point, investigations made in connection with one of the bridges recently constructed by the city of New York, to ascertain how the strength of concrete might be increased so as to act as an adequate filler and stiffener to some cast pedestals, are of interest. It was found by the addition of a certain number of out nails or spikes per cubic foot of concrete the crushing strength, and the tensile correspondingly, was increased enormously, one series of tests giving results as high as 18,000 pounds per square inch, or nearly eight times the ordinary strength.

Similarly, by the plentiful intermingling of large, irregular shaped, more or less elongated, tough bulk-swellers to a mass of concrete, it would appear that the strength must benefit no slight amount. In re-

inforced concrete work, especially, this principle might well be taken advantage of, providing of course conditions are favorable to it, to the end that the concrete act further with the steel to resist tension, thus increasing the actual strength of the whole member. Indeed, it is not at all improbable that, in no very distant future, reinforcement of this nature, that is, supplying resistance to particles throughout the mass, by introducing here and there short pieces of steel, on the tensile side especially, will come into use, thus making concrete a more truly homogeneous structural material. The same principle might also be taken advantage of in columns, in order to keep down the girth and avoid the necessity of steel cones.

All concrete may be looked upon as a combination of mortar with bulk-swellers. Thus the conventional 1:2:4 mixtures might be regarded as composed of one part 1:2 mortar and four parts bulk-swellers. The correctness of the rule as to the proportion of bulk-swellers allowable—to-wit, a volume of them equal to twice the volume of fine material, is now apparent. What, then, it may be asked, is the practical use of regarding the bulk-swellers separately? Just this, that they play no vital part in the proper balancing of the inerts from coarse to fine to secure a dense concrete—it is the fitness, largely, of the mortar in any concrete that determines its density.

This would indicate the feasibility of a standard concrete mixture, one which might be used for any and all purposes, differing only in the proportion and size of the bulk-swellers added. It would be only necessary to agree upon the most suitable and convenient maximum size inert in the concrete-proper. Larger than one-inch would scarcely be possible, as already pointed out; probably one-inch or $\frac{3}{4}$ -inch would best satisfy general requirements. The preparation of good concrete, then, would resolve itself down to the selection of suitable finer grades of material to compare with the maximum grade determined upon, even according to the diagram of grading herein-before outlined. Efforts in the direction of economy in this case, instead of expending themselves in such unworthy ways as skimping the cement, would be confined to improving the grading (which truly economizes on the cement by increasing the amount of it required to produce a given result, not to mention the many other advantages of a scientifically graded mixture), and to incorporating with the mass, either during mixing or thereafter, as many and as large bulk-swellers as conditions favor and judgment approves. If bulk-swellers are added during the mixing, they should be held out until the rest of the material is pretty well intermingled. No specific limit need be set as to their amount relative to a stated volume of fine material (as measured mixed), except to rule that no more of them shall be added than can be readily incorporated. An approximate ratio has already been given, but this may not always indicate the true proportion, more or less; judgment on occasion is the best guide.

ISAAC JOHNSON.

Isaac Charles Johnson, the inventor of Portland cement, resides at Gravesend, England. He has begun his hundredth year. He is still chairman of the board and consulting director of the cement-making firm of I. C. Johnson & Co., Greenhithe and Gateshead, and personally carries on a fairly large correspondence.

THE IDEAL SPECIFICATION FOR CEMENT.

By E. P. Goodrich, Consulting Engineer,
New York City.

A specification for a material is essentially a stipulation limiting its qualities. In preparing such a stipulation, it is almost universally the sole endeavor to protect the user against certain possible qualities which have been found or are suspected of being detrimental to the required efficiency of the material in question, together with the establishment of a lower limit of strength in some cases. With regard to cement to be used for masonry or concrete, several points requisite to a proper article are the following:

It must not disintegrate through the action of the atmosphere, the liquid in which it is submerged (sea water for example), or materials which may come in contact with it by accident or use — in other words, from external causes.

It must not disintegrate from interactions among its constituents—in other words, from internal causes.

It must attain sufficient strength within a few hours to permit practically continuous construction operations—the moving of workmen over it and the erection of centers upon it, for example.

It must attain sufficient strength within a few days to permit the removal of forms if same are required and safely support loads incident to its use in the regular construction.

It must never subsequently suffer a retrogression in strength below the requirements stipulated.

It must never subsequently suffer an alteration of elastic or related properties so as to alter the conditions on which the working stresses have been assumed.

It is only through expert chemical and other analysis of the conditions under which disintegration has been found to take place and of the inherent qualities of the material itself, that proper specifications looking to the prevention of trouble from this cause can be prepared. In the case of cement, for example an undue proportion of the essential chemical constituents of sulphuric acid has been found detrimental. Especially for work in the vicinity of the ocean, quantities of magnesia in excess of a certain limiting value are believed to be objectionable. Again improperly balanced amounts of lime, silica, and alumina (the three principal ingredients of cement) are known sometimes to be the cause of trouble. Under certain circumstances, excesses of either lime or alumina are apt to cause disintegration.

The specifications may be so drawn as to limit these several items between definite higher and lower extremes, the method of determination to be in accordance with definite instructions. Or, these limits may be indirectly set by some stipulation which will bring about the rejection of materials which do not successfully undergo certain tests which have been found experimentally to be more or less closely identified with the phenomena of disintegration, above mentioned. For example, a definite limit assigned to the percentage of magnesia and sulphuric anhydrid, as determined by a chemical analysis carried out in accordance with the methods proposed by the New York section of the Society of Chemical Industry as adopted on a given date, should serve as ample protection with regard to these two ingredients. Again, satisfactory boiling or steaming tests of pats or balls or cylinders of cement paste when carried out in accordance with the methods proposed and the apparatus described by the American Society of Civil Engineers, or the English Engineering Standards Committee, for ex-

ample, are considered sufficient proof that no excess of lime exists.

In order that work may be carried on continuously it is usually essential that the cement, in combination with sand and other necessary aggregates, depending upon the character of the work under ordinary conditions of humidity and temperature of the atmosphere, proportions of water used for mixing, and so forth, shall have attained such a hardness in twenty-four hours that workmen can move over it without causing damage; while, on the other hand, the cement must not be of such composition that it will have become partially set, and thereby lost some of its value, before it can be properly installed in the work. These two conditions can be completely determined by the time of setting and the initial rate of hardening. Some difficulty may be experienced in determining for accurate scientific purposes certain points about the instant at which the initial set commences, its rate of increase and so forth, but for all practical purposes an agreement can be reached as to some test which can be employed for comparative purposes. Since it is the actual hardness in combination with sands and other aggregates which is involved, it would seem that the form which should be given a test concerning this element would preferably be one with regard to the crushing strength or abrasive resistance, rather than one with regard to the tensile strength of pure cement and water, which latter can at best be only an indirect and relative investigation. The ball test proposed by Laborde before the fifth congress of the International Association for Testing Materials seems to fulfill the conditions very well. A coarsely ground cement has been found to attain its hardness very slowly, be more apt to give trouble if an excess of lime happens to be present, and be relatively lacking in the element which has been found to be most closely associated with high cementitious value. A minimum requirement as to the residue left after sifting a designated weight of material for a definite length of time in a sieve of certain dimensions in a given manner is therefore also needed to cover this condition.

Similarly, since cement is never used to any large extent to resist any stresses except those of compression, it would seem that a direct test of this quality, at the end of seven days for example, when necessary for building work, but usually after perhaps a month, would be preferable to any other type of test of strength. This period should be as long as possible and should be determined as the longest interval which can be allowed for the cement test, or the interval after which the structures in which the cement is being used would be required to resist the usual working loads for which it was designed.

Similar but much longer time tests of strength and of the elastic properties of concrete or masonry built with the special cement in question are of the utmost importance. It is obviously impossible to make such long time tests before deciding about the special cement to be used in any case, so that the importance of the work must largely govern the selection or exclusion of any special article, and such action of the deciding body must be based almost entirely upon an accurate history of each special make in question. It is this idea which underlies a paragraph often found in cement specifications which stipulates that only those brands will be considered which have been in use for five years (for example), and of which each manufacturing company has at the present time a properly equipped plant, is properly organized as to personnel, and is on a sound financial basis. It would also seem perfectly proper to include in any specifica-

tion for large engineering enterprises a stipulation that the special kinds of cement proposed for use must be able to show a properly authenticated series of long time tests of strength.

It would therefore seem that the real essentials of a cement specification were the following:

General description (clinkered, powdered, intimate combination of lime, silica, and alumina) giving limits of chemical composition.

Limits of other chemical ingredients (each of the above determined in accordance with certain standard methods).

Fineness of grinding.

Accelerated soundness test (boiling, steaming and so forth, or long exposed to the elements).

Minimum time of initial set.

Minimum hardness after twenty-four hours.

Minimum crushing strength of mortar after the maximum interval which can be allowed for test.

Authentic data as to experience with special brand, its manufacture, long time strength, and so forth.

When properly prepared and enforced, a specification for cement which includes only the above mentioned items would seem to be amply sufficient to secure a satisfactory article. No reason is evident why special neat strengths, special rates of increase, or even special conditions drawn to preclude the so-called adulteration with inert materials, should be incorporated in a specification as long as the above mentioned stipulations are included. And it is believed that, other things being equal, such a specification would be of more economic value than the present ones because it takes account almost entirely of working conditions.

In all probability objection will be made to the historical feature, but the value of a long record cannot be controverted, and a new brand of any material needs to be tried first on unimportant work, and can well afford to make progress only very slowly, proving every step. In this connection a remark found in Trautwine's Civil Engineers' hand book is exceedingly pertinent:

"In selecting a cement, a **reputation**, gained by years of successful use and experiment, is of greater value than the results of a few tests, but such **tests** are of value for excluding inferior parcels of such accepted brands."

(The underscoring is found in the original text.)

It is interesting to note that the Association of German Portland Cement Manufacturers has submitted to their government a proposed standard specification for cement which is even less exacting in the number of items covered than the one outlined above. Their specification is the outcome of long deliberation and an analysis of a series of several thousand tests carried out by a large number of laboratories during the past five years or more. The new proposed standard, if accepted, will take the place of the present one which has been in existence since 1887. The reputation of German Portland cement is well known, but the German product is in absolutely no respect superior to the cement produced in the United States, so that if the German government requirements be made to include only such items as have been discussed, there is no evident reason why specifications of a similar nature should not be adopted in this country.

The Consolidated Rosendale Cement Company has elected directors as follows: J. P. Paulding, A. Lanfear Norrie, Edward Coykendall, J. Graham Rose, H. H. Flemming, Thomas C. Coykendall, Frank Coykendall, H. C. Soop and John B. Cook.

PORTLAND CEMENT IN WASHINGTON AND OREGON.

A very large amount of Portland cement is used in Oregon and Washington for concrete construction, especially in the larger cities—Portland, Seattle, Tacoma, etc. Much of the material is imported from Germany, Belgium, England, and Japan, and a small amount is brought by water from California. Its cost reached \$3.75 a barrel during 1907, but averaged \$3. It is estimated that the total amount of cement used in the three cities above mentioned in 1907 was 1,294,800 barrels, with a value of about \$3,884,400. Of this amount 381,356 barrels were imported into Portland and 369,516 barrels into Puget Sound ports. The latter region also received 263,458 barrels from domestic sources, about two-thirds from California. Several companies have recently been projected for producing cement at various localities in Oregon and Washington, but the only plant now existing is that of the Washington Cement Company at Concrete, a station on a branch of the Great Northern Railway in central Skagit County. The plant was built in 1905 and started in 1907. It has two 100-foot rotary kilns, but will soon add others to the full capacity of the water power, which is derived from the Baker River, on the bank of which the works are erected. A 6 by 10 foot flume carries the water about $2\frac{1}{2}$ miles to the works. Crude oil is used for the kilns and driers. A large supply of high-class limestone is obtained from quarries near by and clay is excavated from the river banks.

The following analysis of the cement was furnished by the company:

Analysis of Portland cement from Concrete, Wash.

Silica	23.96
Iron oxide	3.16
Alumina	6.98
Lime	62.76
Magnesia	1.58
Sulphur as SO ₃	1.31

Ninety-nine per cent of the cement will pass through a 100-mesh screen and 83 per cent through a 200-mesh screen. The setting time is given at $4\frac{1}{2}$ hours for initial set and 8 hours for final set. The tensile strength is given as follows: Twenty-four hours, neat cement, 295 pounds; seven days, neat cement, 773 pounds; seven days, 1 to 3 sand, 276 pounds; twenty-eight days, neat cement, 805 pounds; and twenty-eight days, 1 to 3 sand, 440 pounds. The boiling test gave perfect results. This cement has been extensively tested and several contractors in Seattle assert that it comes up to the best requirements.

From 1887 to 1890 a cement plant was operated at Oregon City by the Portland Cement Company, of Portland, Oreg. This plant was the first to use rotary kilns. A "natural cement rock" from Douglas County, Oreg., was burnt, using gas for fuel, and power from Willamette River. Owing to litigation it was shut down in 1890. Undoubtedly the great expense of hauling limestone from Douglas County was a serious handicap to the project.

Limestone suitable for cement is known to occur at various localities in the State of Washington, but only the deposit in Skagit County is utilized for cement manufacture. Many of the limestone bodies occur far off the main lines of travel and some of them are not sufficiently pure for cement. Doubtless when the geology of the State is completely explored numerous additional localities will be discovered.

(Taken from Bulletin 387 United States Geological Survey.)

A PLANT FOR CURING CONCRETE BLOCKS BY STEAM.

The Central Stone Company, St. Joseph, Mo., manufacturers of concrete blocks, have a four-oven steam curing plant, in which the ovens are built of concrete and are each of sufficient size to accommodate four three-deck block cars at one time. These ovens are stated to give entire satisfaction, and the following data regarding them and the other equipment of the plant are taken from a paper read by Mr. F. S. Phipps before the recent Chicago convention of the National Association of Cement Users.

The ovens are 15 ft. long, $6\frac{1}{2}$ ft. wide and 45 in. high from the floor to the springing line of the arched roof, which has a radius of 3 ft. 3 in., so that the height from the floor to the crown of the arch is 7 ft. The walls are 12 in. thick and are made of concrete blocks. The arches are of solid concrete, reinforced with $\frac{1}{2}$ -in. corrugated bars laid 1 ft. apart transversely and also longitudinally. The arches are 6 in. thick, so that two of them spring from each of the 12-in. walls. This arrangement allows a new oven to be added by building a new side wall, rear wall and arch. The track is laid with second-hand railroad ties, laid about 2 ft. apart on centers. These have been covered with concrete, so that the floor may be kept clean.

The fronts of the ovens are left open, and while curing is in progress are closed by a drop made of the heaviest canvas obtainable. In erecting the ovens $\frac{1}{2}$ -in. bolts are embedded in the front face, and to them are attached 2-in. planks 12 in. wide. The canvas is permanently nailed to these planks around the arch, but the lower portion is merely tacked on lightly with the aid of strips of lath, so that it can be rolled up to pass cars in and out of the ovens. Directly over the front of the ovens is a ventilator to carry the steam out of the building. Experience in other plants has indicated that if a ventilator is not provided, the steam condenses on the ceiling of the shop, and the dripping water injures the work.

Steam is supplied by a 25-hp. boiler, which Mr. Phipps estimates to be large enough to supply steam for 12 ovens of the size employed in his plant. Though the boiler is used at a very low pressure, it is cared for in the same manner as if it were carrying 70 to 80 lb. of steam. It is properly bricked in and covered with asbestos to save as much fuel as possible. A 3-in. pipe is led from the boiler to the ovens, and at each side of each oven a 1-in. pipe drops down to within 1 ft. of the floor, where an elbow connects it with a horizontal pipe running to the back of the oven. The end of the pipe is capped and on its upper side, at intervals of 15 in. $\frac{1}{4}$ -in. holes are placed for the escape of the steam. A valve is placed outside the oven, so that the steam supply can be regulated.

The tracks in the oven are of 24-in. gauge, and the cars are 7 ft. long, so that two of them can be placed on each track, or four to the oven. In this way 100 to 125 blocks are placed in an oven at one time. The pallets are made of white pine and the under side is ripped half way through to prevent warping. They have given satisfaction. Ordinary iron cars are used, but Mr. Phipps is inclined to favor galvanized cars.

The block machines are placed as near as possible to the entrance of the ovens, so that it is not necessary to transfer the green blocks any great distance.

Mr. Phipps estimates the cost of one of these ovens between \$50 and \$60, excluding the cost of the forms for the arch. These will cost about \$20 to \$25 for labor and material. If as many as four ovens can be built, he believes that the average cost, including

forms, will be about \$40 apiece. These figures assume that the manufacturer is making his own blocks and building his own ovens and excludes any profit. He estimates the cost of the boiler at about \$225, and the piping for the ovens at about \$12 per oven. Estimating more liberally and allowing \$250 for the boiler complete, and \$40 apiece for each of the four ovens and \$15 for the piping, the total cost would come to \$470. Mr. Phipps believes that with this type of plant, one-half the fuel will be saved over the ordinary type of upright enclosed boiler and galvanized iron or plaster ovens.

The experience of the Central Stone Company shows that 1000 lb. of coal will cure three to five ovens of blocks, and the cost of the fuel, at \$2.50 per ton, is about 25 cents per oven if 1000 lb. will cure five ovens. This cost Mr. Phipps believes is less than sprinkling and air-curing would cost, the cost of the labor in sprinkling alone being equal to the fuel cost.

Mr. Phipps states that it is absolutely necessary to turn on the steam slowly when starting to cure blocks, otherwise the blocks will become mushy. The boiler should be kept well filled with water, so that the steam will be moist. The steam gauge should never show a pressure above 3 lb., and more often will show no pressure at all. In most cases the blocks are cured in from 24 to 36 hr., and are then taken to the yard. These blocks, of course, are made by the semi-dry process. Poured blocks are left undisturbed for 12 to 20 hr., and then steam-cured for the same period. In some cases it has been necessary to remove the poured work from the ovens after 6 to 12 hours' steaming, and no evil results have followed. After poured work has set in the open for 12 hr., it can be placed in the oven and full steam turned on at once without any bad effect.

DOUBLE-HEADED NAILS FOR FORM CONSTRUCTION.

The Ferro Concrete Construction Company, of Cincinnati, has been experimenting for some time with double-headed nails for use in the construction of forms for concrete work. These experiments have resulted in the development of a nail which, the company states, has given satisfaction.

The nails are of the wire type with heads formed in the usual way. About $\frac{3}{8}$ in. below the head is a square washer forced into position with considerable pressure so that it cannot readily be displaced. The shank of the nail between the head and the washer is enlarged over the rest of the shank and is larger than the hole in the washer. It is not likely, therefore, that the washer will be forced back when driven to a firm bearing, but any tendency to move will force it to a tighter fit on the nail. The washers are made of metal $\frac{3}{32}$ in. thick, $\frac{5}{8}$ in. square for the 12-penny nails, and $\frac{1}{2}$ in. square for the 10-penny nails.

The company states that these nails are of great value in constructing both form work and temporary scaffolding, as they can be driven home and hold more than the standard nail owing to the large area of the square washer. When the form work or scaffolding has to be taken down the nails can be removed without injury to the lumber and if carefully drawn can be used over indefinitely.

They are made by the F. A. Neider Company, of Augusta, Ky.

THE IMPROVED DIETRICH'S CLAMP AND HOLLOW WALL FORM SYSTEM.

The Dietrichs Clamp Co., of Little Ferry, N. J., is now offering an improved form of clamp for holding forms used in concrete construction and has also recently put on the market a system of forms for building a hollow concrete wall which insures freedom from dampness. It is said that by use of this system, 50 per cent. of the cost of forms can be saved. The sketch shown in their advertisement in this issue illustrates the essential principles of the system, the specifications of which are as follows:

1. Panels are built of a spruce frame of which top (A) and bottom (B) rails are 2 inches by 4 inches by 6 feet long, side rails (C) 20 inches long, well nailed together and lengthened by two intermediate (D) 3-inch by 4-inch rails, spaced 18 inches from the end of panels.
2. The frames are covered with $\frac{7}{8}$ -inch spruce (E) planed one side and edged and nailed up and down.
3. Panels for corners of walls to be made 2 feet long and top and bottom rails spliced so the two panels will form a mitre with well secured corner.
4. On each side rail of panel one or two holes are bored to receive iron pins (F) which will be provided with a slot cut near each end so iron wedges (G) can be driven to hold panels tightly together or ordinary machine bolts with thumb screws or wing nut may be used. On each top rail two pieces of iron plate (H) shall be secured by lag screws and placed so as to hold the panels from spreading.
5. To space out inside panels an angle iron (J) is provided. This angle has holes for screws and bolts or pins to secure it to the top rail of each panel and adjust it in its proper position and also has riveted on it a separator (K) the width of which shall be the air space required and the length 4 feet.
6. Before hanging hollow space plates (L) the form work shall be provided with the Dietrichs clamps (M).
7. The hollow space plates are of 18 gage 4 feet 2 inches long by 20 inches wide, provided on each side at their proper height with slot (O) cut so plates will hang on wire (N) of the Dietrich clamps.
8. These plates are connected together on top corner by a pin (P) and holes for pin are so drilled that plates will have 2-inch lap. These pins are provided with an iron hook or shackle to grapple plates when, after concrete is set, plates are to be removed. Method of removing plates is shown on drawing.
9. The iron space plates being 4 feet long makes it convenient to pour concrete for the height of two panels.
10. To provide for openings for windows, dummy frames are placed in outer and inner space of wall form. The dummy in inner side of wall is made larger than in the outer side. The last named is provided with a cove molding so as to form neat ornamental openings. The original window frames will come flush with outer edge of hollow space. Provision is also made for forming openings for window sills and lintels, said sills and lintels to be molded independently in special molds and placed afterwards.

CEMENT DRAIN TILE.

The Universal Portland Cement Company has just issued its pamphlet on "Cement Drain Tile," for the preparation of which the company has been conducting investigations for a considerable length of time. The book opens with a number of facsimile letters from users of cement tile, stating the satisfactory experiences which they have had with it. Following this, the book goes into the detailed results of investigation of cement pipe and tile in various parts of the country, together with photographs which have been taken on the various pieces of work investigated. The book comprises 30 pages and is a strong argument for the use of cement for this class of work. It will be sent to anyone by the Universal Portland Cement Company upon request. Machines for making cement tile are manufactured in Waterloo, Iowa, by the Cement Tile Machinery Company. Write for their new catalogue.

CONCERNING THE BLOCK MAKERS.

D. R. Hill, Bonesteel, S. D., has a force of workmen erecting a building 36x90 for a cement block factory. The past year there has been a growing demand for this class of building material and Mr. Hill will soon be in readiness to meet this growing demand.

* * *

The Bangs & Knuth cement tile and blocks factory, of Dows, Ia., will place a force of men at work in a few days on their factory building, which will be built of cement blocks, 80x200 feet. The company is doing an immense business, and the new quarters are made necessary by its growing trade.

* * *

Among the new industries which are being attracted to Vale, Oreg., is a cement block making plant, which will be installed by E. F. Pharriss & Co. The plant will be of large capacity and will be operated on a large scale.

* * *

Joseph Paternoster, Fairbury, Ill., is enlarging his cement block works in the Arcade block, having secured two more rooms on the west of those now occupied by him.

George Plowman and Fred Hawes, of Laclede, Mo., have bought J. E. Kent's cement block outfit and will open up for business as soon as they find a suitable location.

* * *

J. S. Sandy and J. N. Cash have organized a company to be known as the Monticello Cement Tile Co. (Ind.) with a capital stock of \$15,000.

* * *

J. S. Dowdy & Son, Atlanta, Ill., are preparing for a busy season in the concrete business. They have installed a steam boiler at their block plant in the west end of town and will soon be prepared to cure the blocks by steam. They have also purchased a cement brick machine which is capable of turning out from 8,000 to 10,000 bricks per day. Besides carrying on this work, their work for orders already in for concrete walks will carry them far into the summer.

* * *

The Electrical Cement Post factory at Lake City, Ia., was purchased by John Sims of Minnesota. In the transaction the company will receive 6,742 acres of land in Marshall county, Minnesota, while Mr. Sims will be entitled to all the holdings of the former company in this city. The new proprietor intends to improve the plant and greatly increase the business capacity.

TO BUILD CONCRETE HOMES.

There has been incorporated in New Haven, Conn., the Fireproof Dwellings Company, a concern which will build fireproof dwelling houses of concrete, either on its own land or on the land of others. The capital stock of the concern is \$100,000, of which \$20,000 has been paid in, and the officers and directors are all New Haven men. They are as follows: President, Philip Sellers; vice-president, D. A. Cameron; treasurer, William G. Lotze; secretary, G. A. Saunders. Among the directors is included Frederick J. Sterner, the advisory architect who will have charge of the work.

The new company purposes to construct concrete dwellings along lines which have been exploited in England and Germany, but not used heretofore in this country. Both exterior and interior are of concrete. It is the purpose of the company to confine its activities to Long Island for the present. Its plans calling for the erection of ten of its models of houses for occupancy next spring.

NEW CEMENT BRICK COMPANY.

The Pyramid Cement Products Company, of Los Angeles, has been incorporated with a capital stock of \$300,000, by J. P. Johnson, H. E. Peterson, N. Englander, F. W. and F. J. Neumann. The company expects to start the plant for the manufacture of bricks from cement and sand by the Rolfe patent, at a cost of \$70,000, at Manhattan Beach, Cal. The capacity of the plant will be 25,000 bricks a day and will be increased to a greater amount if the demand warrants the enlargement of the plant. At present the company has orders for 600,000 bricks, and it is expected that these orders will amount to a still greater figure before the completion of the plant. This is the first company in the southwest to manufacture these bricks under the Rolfe patent, and it is expected that there will be no competition from the factories making these bricks at Alameda, Cal., and Spokane, Wash., on account of transportation rates.

The Pittsburg Testing Laboratory, with general offices at 325 Water Street, Pittsburgh, Pa., announce that on account of the rapid growth in their cement testing department, they have recently opened cement laboratories, with full facilities in charge of competent cement chemists and cement testers at No. 511 Omaha bldg., Chicago; also at 305-306 Praetorian bldg., Dallas, Texas. They also have cement laboratories at Easton, Pa., Pittsburgh, Cincinnati, Birmingham and San Francisco, as well as cement chemists located at a large number of the different cement mills, and that they are prepared to test cement either in their laboratories, or to make mill inspection of cement at any of the leading cement mills.

CEMENT SHOW FOR NEW YORK.

After consulting many of the exhibitors at the recent Chicago Cement Show, the Cement Products Exhibition Company has decided to hold a show in New York City. Madison Square Garden has been leased for an exhibition from about December 14 to December 20, 1910. Many of those who exhibited at the Chicago show have already expressed their intention to make a display at New York.

"HOW TO USE CONCRETE."

The Concrete Publishing Company, of Detroit, Mich., has just published a book entitled, "How to Use Concrete," compiled by Walter C. Boynton, editor of "Concrete," and R. Marshall, associate editor. The object of the book is to give practical information about the uses of concrete, for both decorative and constructive purposes. As the book is intended to serve rather as a primer for those unacquainted with the uses of concrete, all technical terms have been eschewed. The book should prove of interest, however, not only to beginners, but also to those conversant with the uses of concrete, as it contains some valuable suggestions. The book contains 230 pages and is profusely illustrated, including many working drawings. Besides treating of almost all possible uses of concrete, the book has some valuable cost data. It is bound in full cloth and sells at \$1.00.



J. H. Stewart J. M. Schenk W. H. Stewart
Vice-President and Inventor and Sales Manager
Treasurer President

THE MEN BEHIND THE CEMENT TILE MACHINERY COMPANY.

The Cement Tile Machinery Company, of Waterloo, Iowa, has been very active in its field for several years, and has grown from small beginnings to be one of the largest in its line in the world. The work of building up this business is characteristic of the men who are at the head of it, Mr. J. M. Schenk, Mr. J. H. Stewart and his son, Mr. W. H. Stewart.

MODERN CONSTRUCTIVE METHODS AS COMPARED WITH ANCIENT.

The difference between the ancient and modern achievements of man lies not so much in the magnitude of the work done, as in the methods employed. The pyramids built by the Pharaohs compare favorably with, if they do not excel, any modern structure of stone and the ancient Greeks built temples and dug canals which are quite as gigantic as anything we can boast of in these days. Those early examples of the builder's art were in most cases undertaken for the purpose of giving employment to vast hordes of enslaved people who could only be kept in subjection this way. In other words, cheap labor and lots of it made these ancient structures possible, nay even necessary. The mythological labors of Hercules were god-like to those ancients because they were performed single-handed,—today they would smack of the common place besides the one-man powers, rendered possible by them.

In the digging of the Panama Canal we see an example of the modern method of carrying on a gigantic enterprise with comparatively few men. The monster steam shovels operated by one man scoop up yards of earth with one scoop of its giant arm into cars which a steam engine, driven by one man, rushes to the dump ground. Here a couple of men can dump a train load. When it is necessary to extend the fill or widen

the fact that the work to be done must be completed in a very short limited time, in order that there may be profit in it for the contractor. It also results from the adverse conditions of weather under which the contractor must often prosecute his tasks, and which, perhaps, affect them more seriously than they would a project carried on upon a larger scale.

A noteworthy demonstration of the advantages re-



Showing the entire equipment which enabled the contractors to break the worlds record.

it, a steam crane, operated by one man, lifts the track and places it at the desired spot. If it is necessary to loosen the earth for the shovel or tear down the rock-bound facade of the hill, a blast, fired by one man, does the work in the twinkling of an eye.

These modern methods of accomplishing heroic tasks are just as noticeable in some less important private undertakings. Indeed, they may be said to be reduced in these cases to an even greater degree of refinement. This is made necessary, in most cases, by

sulting from employing up-to-date methods is to be found in the construction by the Nicola Building Company of the base-ball grounds, known as Forbes Field, for the Pittsburg Base Ball Club. The work on this, the finest athletic grounds in this country, was started on January 25th, 1909 and completed in contract time on May 25 of the same year, a total of 120 days. The work consisted in the construction of an immense three-story steel and concrete grand stand capable of seating 20,000 people, also steel and concrete bleachers with a seating capacity of 10,000 and the necessary



The dump cars used in the work showing the rapid method of dumping material.

excavating and filling to convert a steep hillside into a level field.

In the construction of this field about 40,000 cubic yards of earth were handled. This was done by means of steam shovels and dump cars, the track for the latter having a total length of over 4000 feet. A few scrapers were used at the start but it was found that this method was entirely too slow and expensive when the length of the haul exceeded 500 feet. They were therefore discarded.

The time of the year during which the work was done made progress difficult and only possible at all by using the most up-to-date equipment. The fills under the rain and snow of early spring, became so soft and treacherous that they would not bear up heavy dump cars and engines. Under these conditions the Nicola company had to rely almost entirely on the light steel cars and tracks which they rented from the Orenstein-Arthur Koppel Company and to discard the heavy wooden ones. The capacity of these cars was one cubic yard each and the weight 920 pounds. The track was made in sections 15 feet long, each section weighing about 120 pounds.

These steel cars could be propelled and dumped by one man without great effort and the portable steel track sections could be lifted by one man easily and placed wherever desired. By means of this equipment it was possible to bring the car both in loading and unloading to the spot where the work could be done to the best advantage, saving manual labor as much as possible. In unloading, the earth could be dumped at the side or end of the car clear of the track and the track moved sideways or extended as the fill widened or lengthened.

The low cost of this system of excavating was demonstrated in this undertaking quite as conclusively as its convenience and rapidity. When the work was first planned bids from outside contractors were requested for the excavating. The lowest of these was 60 cents per cubic yard. The Nicola company decided to do the work themselves and, when it was finished, the cost per cubic yard was found to have been only 20 cents per cubic yard. Here indeed was very practical evidence of the advantage attending up-to-date methods. It should be remembered that the steel car equipment was only rented from the manufacturers so that there was no money tied up in it and no interest, depreciation or other fixed charges to figure on.

NEW CEMENT PLANTS.

It is reported that the Freeborn Engineering & Construction Co. of Kansas City, Mo., has been given the contract for the erection of a \$1,000,000 cement plant for the International Cement Company at Juarez, Mexico.

* * *

The Dominion Cement Co., of Montreal, has been incorporated with a capital of \$5,000,000. This company has been making investigations in Canada for some time in regard to locations offering the best advantages for manufacture.

* * *

The American Cement Plaster Co., of Lawrence, Kansas, are about to let contracts for the erection of a modern up-to-date plaster mill at Fort Dodge, Iowa, to cost about \$150,000. The American Cement Plaster Co. recently purchased the plant of the Iowa Hard Plaster Co., of Fort Dodge.

CANADIAN PRODUCTION OF PORTLAND CEMENT.

Statistics of the Consumption and Production of Portland Cement in Canada for the year 1909—Interesting Comparisons with the Figures of 1907 and 1908—Other Statistics Covering Canadian Cement Manufacturers.

The history of the production of Portland cement in Canada as in other countries is one of progress and rapid development, and, with the marvelous increase of building and contracting work that the Dominion promises, the growth of the future will be even more marked. Several interesting comparisons can be made and inferences drawn from the figures of the past few years. The average price of Portland cement manufactured in Canada for the past four years show considerable variation. During 1906 prices ranged from \$1.65 to \$1.70; during 1907, \$1.60. In 1908 the price dropped to \$1.39. During the past year the price per barrel at the mill was \$1.31. These figures show a gradual decrease in the price of cement during this period. For the present year, however, a much higher figure will be recorded, as it is selling at the present time at \$1.60 in thousand-barrel lots. Increased cost of labor and fuel has reduced the profits in its manufacture, but this has been largely met by the installation of labor-saving machinery, greatly reducing the cost of manufacture.

Wages paid and the number of those employed has increased proportionately during this period. One plant only has produced slag cement, which plant has registered an increased output and increased demand. The quantity of natural cement produced has gradually fallen off, until at present little or none is manufactured. The greatest demand for this cement was principally previous to the year 1910. During the past year the value of natural cement produced amounted to less than \$1,000. Increased stocks on hand at the end of each year is noticeable from the figures given. Since 1906 there has been a growing tendency to manufacture from limestone rather than marl. This has been apparent in the remodelling of more plants and in the changes of location.

Complete statistics have been received by the Department of Mines from all but two Canadian cement manufacturers for 1909. These, however, will not increase the totals by more than 2 or 3 per cent. Subject to this correction the total quantity of cement made during the year was 4,089,191 barrels as compared with 3,495,961 barrels in 1908, an increase of 593,230 barrels, or 17 per cent. The total quantity of Canadian Portland cement sold during the year was 4,010,180 barrels, as compared with 2,665,289 barrels in 1908, an increase of 1,344,891 barrels, or 50 per cent. The total consumption of Portland cement in 1909, including Canadian and imported cement, was 4,152,374 barrels, as compared with 3,134,338 barrels in 1908, an increase of 1,018,036 barrels, or 32 per cent.

Detailed statistics of production during the past three years have been as follows:—

	1907.	1908.	1909.
	Barrels.	Barrels.	Barrels.
Portland cement sold	2,436,092	2,665,289	4,010,180
Portland cement manufactured ..	2,491,513	3,495,961	4,089,191
Stock on hand Jan. 1	299,015	383,349	1,093,493
Stock on hand Dec. 31	352,435	1,214,011	1,172,504
Value of cement sold	\$3,777,328	\$3,709,063	\$5,266,008
Wages paid.....	956,080	1,271,638	1,182,090
Men employed ..	1,786	3,029	2,411

The average price per barrel at the works in 1909 was \$1.31 as compared with \$1.39 in 1908. The imports of Portland cement into Canada during the twelve months ending December 31st, 1909, were 497,678 cwt., valued at \$166,669. This is equivalent to 142,194 barrels of 350 pounds at an average price per barrel of \$1.17. The imports in 1908 were 469,049 barrels, valued at \$531,045, or an average price per barrel of \$1.13. The duty is 12½ cents per hundred pounds. As there is very little cement exported from Canada, the consumption is practically by the Canadian sales, together with the imports.

Following is an estimate of the Canadian consumption of Portland cement for the past five years:—

Calendar Years.	Canadian.		Imported.	
	Barrels.	P.c.	Barrels.	P.c.
1905.....	1,346,548	59	918,701	41
1906.....	2,119,764	76	665,845	24
1907.....	2,436,093	78	672,630	22
1908.....	2,665,289	85	469,049	15
1909.....	4,010,180	97	142,194	3
	Total.			
			Barrels.	P.c.
1905.....			2,285,249	.....
1906.....			2,785,609	.....
1907.....			3,108,723	.....
1908.....			3,134,338	.....
1909.....			4,152,374	.....

RECENTLY PUBLISHED BOOKS.

INSPECTOR'S HANDBOOK OF REINFORCED CONCRETE.—By Walter F. Ballinger and Emile G. Perrot. Cloth; 2¾ x 6¾ in.; pp. 66; six folding plates. \$1.00 net. New York. Engineering News Book Department.

This book is issued by members of a firm of architects who have experienced the usual difficulty in securing the services of properly trained inspectors in the construction of reinforced concrete in buildings. It may well be considered a book of instruction for inspectors, pointing out the essential requirements pertinent to building construction of this class.

The subject matter is treated under three main headings: Forms of Falsework, Reinforcement, and Concrete. The appendix contains elementary discussions of beams and columns, with six tables. The six accompanying diagrams are designed to give the strength of reinforced concrete slabs and T-beams.

Architects and engineers generally, who have to do with reinforced concrete, will welcome this little volume for the practical aid it will give in procuring safer structures and better qualities of work in a class of construction which, however well designed, may, if improperly inspected, be rendered absolutely unsafe.

A new catalog describing the Burness trucks has been issued. This truck has two wheels, handled at one end, the other end being so arranged as to swing from the top so that the concrete can be dumped. The cart is equipped with "eyes" for the attachment of tackle so that the cart can be lifted bodily like a bucket. The Burness Concrete Truck Co., Scarritt Bldg., Kansas City, Mo., are the manufacturers.

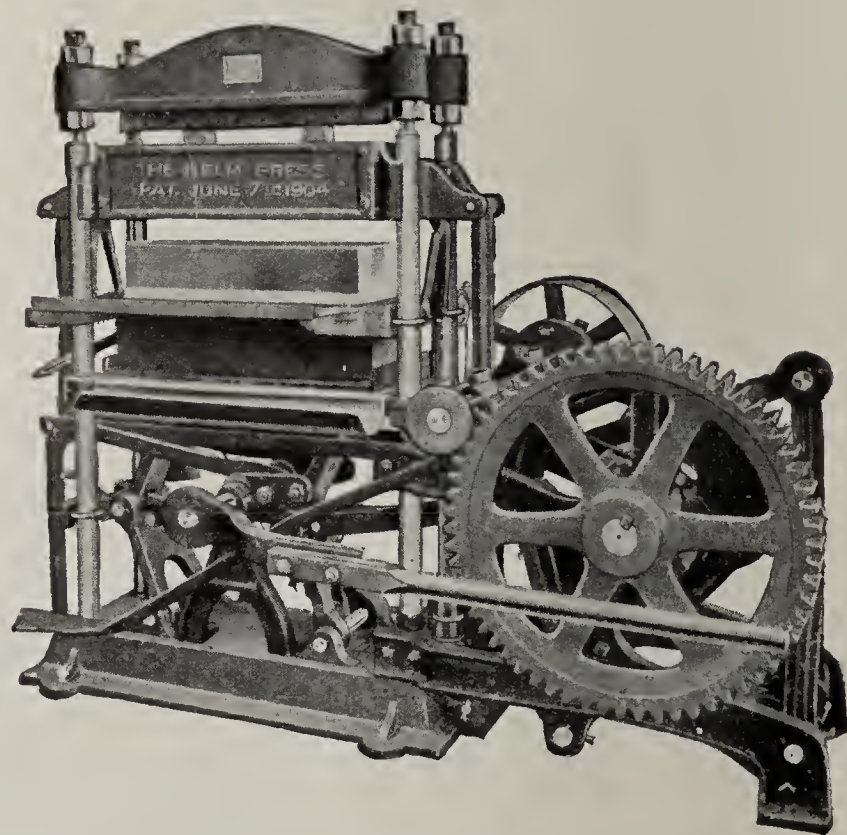
In Montour Falls, N. Y., work has been commenced on the new building for the Hercules Concrete Pipe Company. The new company is composed of Fred Stockley, the patentee, and E. A. Dunham & Co.

IMPROVED HELM PRESSES.

The permanency of the concrete industry and the wonderful forward strides in the sale and use of concrete products are strikingly demonstrated by the improvements in concrete machinery which are being made by up to date manufacturers. Every precaution is being taken to turn time and labor into the greatest possible returns. As the industry grows and competition develops the operators of concrete plants must look carefully to labor-saving methods.

The Queen City Brick Machine Co., Traverse City, Mich., manufacturer of the Helm presses, has brought out this year a power machine for making both concrete brick and block. This machine is illustrated herewith. It exerts enormous pressure and produces ten brick or one block at a single operation. It is easily operated three times a minute with a capacity of about 15,000 pressed brick or 1,500 pressed dry wall two-piece block daily. This press works automatically, requiring but little hand labor. In a test made on this power machine in the plant of J. W. Belknap & Son, Greenville, Mich., four men put through 600 perfect brick in 15 minutes, one man filling the conveyors, one operating the press and the other two doing the off-bearing. This is at the rate of 24,000 brick a day, calling for four complete operations per minute.

The manufacturers report that this power machine has met with instant favor. This machine and the complete line of Helm presses is fully illustrated and described in a concrete book which the Queen City Brick Machine Co. is mailing free on request.



Helm Block and Brick Power Machine.

*Transfer of the entire property of the Chanute Cement and Clay Product Company to the New Bronson Portland Cement Company (a new organization) has been recently made. The plant is located at Bronson, Mich., and has a capacity of 1,000 barrels per day. Improvements will be made immediately.

PROPOSED STANDARD SPECIFICATIONS FOR ARCHITECTURAL CONCRETE BLOCKS.

Materials.

Cement. The cement shall meet the requirements of the Standard Specifications for Portland Cement of the American Society for Testing Materials, and adopted by this association (Standard No. 1).

Fine Aggregate shall consist of sand, crushed stone, or gravel screenings graded from fine to coarse, passing when dry a screen having $\frac{1}{4}$ -in. diameter holes, shall be preferably of silicious materials, clean, coarse, free from vegetable loam or other deleterious matter, and not more than 6 per cent. shall pass a sieve having 100 meshes per linear inch.

Mortars composed of one part Portland cement and three parts fine aggregate by weight when made into briquets shall show a tensile strength of at least 70 per cent of the strength of 1:3 mortar of the same consistency made with the same cement and standard Ottawa sand.

Coarse Aggregate shall consist of inert material, graded in size, such as crushed stone or gravel, which is retained on a screen having $\frac{1}{4}$ -inch diameter holes and will pass a $1\frac{1}{4}$ -in. ring, shall be clean, hard, durable, and free from all deleterious matter. Aggregates containing soft, flat or elongated particles, shall be excluded.

Water shall be clean, free from oil, acid, strong alkalies or vegetable matter.

Proportions.

A bag of Portland cement weighing 94 pounds shall be considered as one (1) cubic foot. All concrete shall be prepared and mixed in quantities requiring one or more full bags of cement; the use of any device for mechanically proportioning the materials is prohibited.

Backing. The backing of all block shall be made of one part Portland cement, two parts fine aggregate and four parts coarse aggregate (1:2:4.)

Facing. The facing shall consist of one part Portland cement, two parts fine aggregate (1:2), and shall be one (1) inch in thickness. It shall be thoroughly tamped into place in the mold and the backing immediately deposited. In order to prevent checks and hair cracks troweling will not be permitted.

Only cement of the same color shall be used. Cements causing efflorescence shall not be used.

The facing material shall not be allowed to become lumpy and shall be screened if necessary.

Where color is required, only mineral colors shall be used.

Mixing.

The ingredients of concrete shall be thoroughly mixed dry, sufficient water added to obtain the desired consistency, and the mixing shall continue until the cement is uniformly distributed and the mass is uniform in color and homogeneous.

a. Measuring Proportions. Methods of measurement of the proportions of the various ingredients, including the water, shall be used which will secure separate uniform measurements at all times.

b. Machine Mixing. When the conditions will permit, a machine mixer of a type which insures the proper mixing of the materials throughout the mass shall be used.

c. Hand Mixing. When it is necessary to mix by hand, the mixing shall be on a water-tight platform and the materials shall be turned until they are homogeneous in appearance and color.

d. Consistency. The materials shall be mixed so as to provide sufficient water to insure a proper bonding and a dense concrete free from voids.

e. Retempering. Retempering mortar or concrete, i. e., remixing with water after it has partially set, shall not be permitted.

Reinforcement.

Bending. Sufficient metal reinforcement shall be provided to carry all stresses produced by the loads to which the blocks will be subjected.

Shrinkage. No shrinkage reinforcement is required in blocks whose least dimension is more than one-third ($\frac{1}{3}$) of the length, such length being less than three (3) feet.

All blocks less than four (4) inches square shall have in the center at least one bar equal to $\frac{1}{2}$ of 1 per cent of the cross section.

All blocks over four (4) inches square shall have at least four $\frac{1}{4}$ -inch square bars, with mechanical grip extending throughout the length of the stone. one bar to be placed in each corner.

All blocks of over fifty (50) square inches in cross section shall have reinforcement equal to at least $\frac{1}{2}$ of 1 per cent of the cross-sectional area. The reinforcement shall be placed within $\frac{1}{2}$ in. of the face of the block, and the bars shall not be more than 8 inches between centers, care being taken to place a bar in each corner or projection. Bars shall be hooped with bands or wires not more than 8 inches between centers.

Protection of Corners.

All corners and edges shall be sharp and well defined. They shall have true horizontal and vertical lines and no block will be accepted that is chipped or marred in any manner.

Curing.

Natural Curing. For the purpose of securing proper curing, the blocks shall be protected from the sun and strong currents of air, shall be sprinkled at such regular intervals as necessary to prevent drying, and such other precautions taken as to enable the final set to take place under the most favorable conditions.

At least twenty (20) days shall be allowed for curing.

Steam Curing. The blocks shall be removed from the molds as soon as the conditions will permit and shall be placed in an atmosphere of steam saturated with moisture for a period of at least forty-eight (48) hours. The blocks shall then be removed and stored for at least fourteen (14) days before use, being sprinkled three times a day during the first seven days. care to be taken to maintain the temperature at not less than 50 degrees Fahr.

Laying.

Before laying, the various blocks and adjoining work shall be thoroughly moistened to prevent the absorption of water from the mortar. The mortar shall be composed of one part Portland cement, three parts sand and one part thoroughly slacked lime.

Blocks Cast in Place.

If the block is cast in place, the forms shall be sand-papered, shellaced, oiled, and if necessary sprinkled. A 1:2 mixture one (1) inch thick shall be placed next to the forms and a backing of very wet concrete of 1:2:4 mixture added. In order to prevent checks and hair cracks troweling will not be permitted. All blocks shall be properly protected until accepted.

Discoloration.

All blocks shall have uniform color.

LAYING CONCRETE UNDER WATER—DETROIT RIVER TUNNEL.

By Olaff Hoff.

When reviewing the great number of subaqueous structures as designed and constructed by engineers in the past, one cannot fail to note the hesitancy and diffidence with which they have approached the problem of depositing concrete under water, and how they apparently have resorted to this expedient, by way of compromise, where none other seemed available, except, at an unjustifiable expense.

The reasons are obvious, the chief difficulty among the many presenting themselves being to convey the mass of semi-fluid concrete mixture through water to its place of deposit in such a manner as to preserve the mixture intact and prevent segregation of its integral parts, which would leave only an inert mass of aggregate. As a consequence the application of this method has been very limited, and the experience gained equally so.

Various expedients and devices have been adopted for solving the problem, the principal ones being the use of bags, drop bottom buckets, and tremies, all subject to objections peculiar to each.

Laying concrete under water by means of bags involves the use of divers in placing the bags, and is accordingly cumbersome, slow, and expensive; the results are not wholly satisfactory and the method should be classed as obsolete.

Neither is the use of drop bottom buckets all that could be desired; even with the greatest care it is not possible to prevent the mass from dropping a short distance through the water, which, thus set in motion, has a tendency to remove the cement from the aggregate and produce a lean concrete in spots, where a uniform and homogeneous structure is the ideal sought for. Irregular cleavage lines in the concrete are likely to occur, which objection is also applicable to the use of bags.

The depositing of concrete in water by means of tremies has heretofore presented difficulties which have not always produced satisfactory results. A tremie is nothing more or less than a long tube reaching from the place where the concrete is to be deposited to the surface of the water above, its upper end being provided with a hopper for receiving the mixture; as fast as the concrete escapes at the lower end of the tube it is replenished at the upper end, thus flowing in a continual stream.

Theoretically this is the ideal way of laying concrete under water, but when reduced to practice the object has not proved so easy of accomplishment. The difficulty has principally been to control the flow of the concrete through the tube and prevent the water from the outside rushing into the tube from below, thus washing the concrete and separating the cement from the aggregate, losing the charge; the concrete would be liable to run out either too fast or too slow. Generally the concrete has been deposited in layers of various thicknesses, governed by the position of the mouth of the tremie with reference to that of the layers below. This also of necessity results in a certain amount of motion of the concrete through the water, with attending loss of cement.

These difficulties were successfully overcome in the construction of the Detroit River tunnel, more than one hundred thousand cubic yards of concrete having been deposited in water by means of tremies; the operation extending over a period of part of three seasons, 197, 1908 and 1909.

The excavation of the trench was done with an

ordinary clam shell dredge, well in advance of the sinking of the tubes. The tubes were circular in form with a diameter of 23 feet and 4 inches, and were arranged and sunk in pairs, one tube for each track; they were built of $\frac{3}{8}$ -inch steel plates. They were spaced three feet apart between the shells and re-enforced on the outside by a series of transverse steel partitions or diaphragms, 12 feet apart. These diaphragms extended all around the tubes and were approximately of rectangular shape with an extreme depth of 30 feet 4 inches and extreme width of 55 feet 8 inches; thus extending beyond the steel shell 3 feet at the bottom, 3 feet on the sides and 4 feet on the top of the tubes. They were strengthened by means of double angle irons riveted along the edges; wooden sheathing running lengthwise of the tubes was bolted along the vertical edges of the diaphragms. The tubes were built in lengths of 262 feet 6 inches and were provided with temporary wooden bulk heads at the ends so that they would float when launched.

For the purpose of sinking the tubes they were equipped with four buoyancy cylinders attached on top, which enabled the tubes, when filled with water, to be kept in suspension at any point, lowered to the final resting place by means of floating derricks and connected up with the tubes already sunk.

Before sinking a platform was built in the bottom of trench at the proper level to temporarily support the ends of the tubes. When in their final position the tubes underneath would be from 5 to 7 feet from the bottom of the trench depending upon how near the correct level this was excavated. The diaphragms crosswise of the tubes, and the wooden sheathing on all sides parallel with the tubes, would then present, in exterior view, a series of pockets open at the top and bottom, but with enclosed sides and ends. Into these pockets concrete was poured by means of three tremies, one placed in the middle between the two tubes, and one on the outside of each tube, between the steel shell and the wooden sheathing.

The mode of procedure in placing the concrete was, generally, first to concrete in the bottom to the under side of the diaphragms, thus sealing the pockets and affording support for the tubes. The buoyancy cylinders holding the tubes in suspension could then be removed, and each pocket filled with concrete in one continuous operation, forming a monolithic mass of a thickness of 3 feet on all sides of and between the tubes, 4 feet to 4 feet 6 inches on top of the tubes, and a thickness of 5 to 7 feet underneath the tubes, varying with the irregularity of the bottom.

Generally every other tube length was provided with an extra strong bulkhead at the extreme end, capable of resisting the full hydrostatic pressure when the tubes were pumped out, in order to give access to the interior and permit the placing of the concrete lining.

The equipment used for the purpose of placing the subaqueous concrete consisted of a "tremie scow," so called, especially designed and built for the purpose. This scow was 35 feet in width, 155 feet in length and 9 feet 9 inches in depth with a free board of about 4 feet. It was equipped with 4 spuds, one in each corner, of 20 inches square, 90 feet long Oregon fir timbers, and necessary spud hoists. The object of these spuds was to hold the scow steady during concreting, and prevent any rocking motions caused by waves, or the wash from passing steamers. The scow was further held in position against the current by anchors and was equipped with deck hoists for handling. On one side of the scow was built three towers 82 feet high above the deck, one for each

tremie; the front of these towers served the purpose of leaders (similar to those of a pile driver) for the tremie pipes, which could be hoisted clear out of the water or lowered down to the bottom of the trench, as required. There were three concrete mixers, one for the middle tremie with a capacity of about 30 cubic feet to the batch, and two concrete mixers, one for each of the side tremies with a capacity of about 20 cubic feet to the batch. The equipment further consisted of an air compressor, a dynamo, and an electric conveyor for conveying cement to the charging floor from scows alongside the tremie scow, three hoisting engines for the tremies, two large derricks with hoisting engines for unloading gravel, and a 150 H. P. boiler.

Gravel was used for mixing the concrete in preference to broken stone; it was of size grading from that of small walnuts downwards. Mixed with approximately the proper amount of sand it was found and pumped out of the river near Port Huron, Mich., some 60 miles away from the tunnel site and transported in boats or barges down the Detroit River to the tunnel. The tremie scow was designated particularly for the purpose of handling and mixing this gravel as cheaply as possible. The gravel was unloaded directly from the boat to the tremie scow and used up about as fast as unloaded. To this end the tremie scow was equipped with two heavy derricks located about at the quarter points of the scow on the opposite side to that of the tremie towers. These derricks were operated by large hoisting engines located on the deck of the scow, the gravel being unloaded by means of clam shell buckets and discharged into two hoppers located 32 feet above the deck of the scow, immediately behind the towers. From these hoppers the gravel would fall over inclined screens into receiving bins, being thus screened by gravity, the sand running off into one bin and the gravel into another. There was one sand bin and one gravel bin for each tremie. The bins for the center tremie were of about twice the capacity of the others, because this tremie had to deposit approximately twice as much concrete. The screens below the unloading hoppers were four in number, two for each hopper, inclined in opposite directions so that the gravel would feed one-half to the bin of the side tremie, and one-half to that of the center tremie. The sand and gravel bins were placed a few feet above the charging floor which was located 11 feet above the deck of the scow, and was on a level with the top of the charging hopper of the concrete mixers. Through gates in the bottom of the bins the proper amount of gravel and sand could be drawn into the charging hoppers. This floor was large enough to hold a sufficient quantity of cement for one pocket. The water tank was also located on this floor, from which water was piped to the mixers.

The concrete mixers were placed directly on the deck and when tilted would discharge into self dumping buckets, placed in the hull of the scow directly in front of the mixers; these buckets could be hoisted up to any point where the receiving hoppers of the tremies might happen to be located and discharge their contents into same.

The total amount of concrete in one pocket was about 342 cubic yards, of which approximately one-half had to be deposited through the center tremie and one-fourth through each of the side tremies.

Each tremie consisted of a 12-inch diameter spiral riveted steel pipe of No. 10 metal, 80 feet long, made in 20 foot lengths provided with external flanges for bolting up. The upper end of the tremie pipe was suspended from a frame, to which was attached a hop-

per for charging the tremie, the hoppers with frames running between guides attached to the front of the before mentioned towers. The tremie pipes, hoppers and all could be raised and lowered by means of steel hoisting ropes leading over sheaves at the top of the scow. The buckets in the hold of the scow upon receiving a charge from the concrete mixers were hoisted up inside the towers until they reached the tremie hoppers, which would engage them and trip them forward, discharging their contents into the hoppers; then they would reverse and go down to their place in the hold of the scow. These buckets ran between guides located inside the towers immediately in the rear of the guides of the tremie hoppers. The concrete in passing from a mixer into the bucket would discharge over an apron which the bucket would trip forward every time it descended and trip back out of the way when hoisted up. The tremie hoppers were provided with a small platform on the outside and a railing around same where a man could stand and watch the concrete in the tremie, whether it was running out too fast or too slow, and give signal accordingly to the engineer who ran the corresponding engine.

The working force for operating the tremie scow when the process of concreting was going on, was thirty-two men, on an average.

The operation was as follows: The tremie scow was anchored across the tunnel tubes in the trench, so that the tremies when lowered into place would come in the middle of a pocket, as already stated, one tremie between the tubes and one on the outside of each tube between the steel shell and the sheathing. The spuds were then lowered to the bottom and forced down sufficiently to take up a considerable load from the scow and prevent any rocking motions. The three tremie pipes were lowered into position until their lower ends rested on the bottom of the trench; the water inside of the tremie tubes would, of course, be at the same level with the water outside. Meanwhile the boat loaded with gravel would be placed alongside the tremie scow on the opposite side. The gravel with its mixture of sand would then be unloaded by means of the clam shells and derricks, and dropped into the hoppers previously described, falling over the inclined screens, the sand and gravel shooting off into their respective bins, from which they would in turn be drawn, as required, into the super hoppers of the concrete mixers, cement added, and the charge shot into the mixers, where the necessary water was added in the usual way.

A wadding of cement sacks was at first placed in each tremie on top of the water to prevent the concrete from dropping through, while filling the pipe. A batch of concrete was discharged from the mixer into the bucket in the hold of the scow and hoisted up until a projecting arm on the receiving hopper of the tremie would cause the bucket to tilt forward and discharge the contents into the tremie hopper and on top of the wadding, the bucket immediately returning to its original place to receive a new charge, already in the process of mixing. When this hopper was about half filled, the tremie and hopper would be raised a trifle, permitting the water in the tremie to escape at the bottom as the weight of the concrete pushed the wadding downwards through the pipe. Meanwhile fresh batches of concrete were being dumped into the tremie hoppers. In this manner the tremie was filled with concrete until the wadding reached the bottom and the concrete commenced to run out of the pipes. As fast as the concrete ran out at the lower end of the tremie pipe, fresh concrete would be added to the upper end

of same, this process going on until the whole pocket was filled.

This wadding of cement bags was used only at the beginning of the work. It was soon found that one or two very dry batches of concrete would serve the same purpose, and this was used practically throughout the work in charging the tremie in the beginning of an operation.

The concrete, except as noted in charging the tremies, was mixed very wet, much more so than would be permissible in concrete deposited in the air. No difficulty, however, was experienced on this account. The gravel showed no tendency to segregate from the mixture, probably because the mass was always in a slow and uniform motion, and when it reached its place of deposit the mass would be under a heavy hydrostatic pressure, that may have had the effect in connection with the loss of weight on account of buoyancy, of making segregation more difficult.

It should be particularly noted, that the mouth of the tremie was always buried in the concrete from two to five feet, forming an effective seal which, at all time, prevented the outside water from forcing itself into the tremie. It was the duty of the inspector on the platform of the tremie hopper to always be on the look-out that the tremie was full of concrete. If the concrete showed a tendency to run out too fast he would signal the hoisting engineer to lower the tremie and thus choke off the flow; if the concrete did not flow fast enough he would order the tremie raised until the concrete would flow more rapidly.

It is a fact, that after a week or so, when the men on the concrete scow had become thoroughly familiar with their duties, not a single charge was lost in depositing more than one hundred thousand cubic yards of concrete. The concrete when deposited, would take an exceedingly flat slope, in fact, practically seek its own level. Occasionally a small mound would be built up around the mouth of the tremie, but the least agitation of same would cause the mound to spread out to a practically level surface. As soon as the pocket was finished the concrete scow was shifted to the next one. No pocket was ever started unless the necessary materials of sand, gravel and cement were on hand to complete it.

In depositing the concrete divers were employed for inspecting the progress of the work.

The time required for filling one pocket usually ran from four to seven hours. The largest amount of concrete placed by the tremie scow per day was three pockets, or 1,025 cubic yards, working sixteen hours. This includes the time required for replacing the gravel boats, alongside the tremie scow. These boats generally held enough gravel for one pocket. The amount of concrete that could be placed depended mostly upon the supply of gravel. Usually three pockets were concreted in two days, that is one pocket one day and two pockets the next.

As previously stated, the bottom of the trench was first filled with concrete, to the under side of the diaphragms; this generally required from four to five days, sometimes a little longer, for each tube length.

The length of time of mixing a batch was usually from two to three minutes. The time for the concrete to reach its place of deposit from the mixer would, of course, vary greatly, but the average time was probably about eight minutes, with a minimum of five minutes and a maximum of fifteen. The velocity of the flow of concrete in the tremies would average from fourteen to fifteen feet per minute. The extremes probably running from seven feet to twenty-five feet.

The concrete was mixed in the following proportions: In the bottom of the trench below the dia-

phragms it consisted of one part of cement to four parts of sand and eight parts of gravel. The concrete in the pockets consisted of one part of cement to three parts of sand and six parts of gravel. Gravel of small walnut size was used in preference to crushed stone as it was thought it would cause the concrete to flow easier in the tremies, besides gravel makes a denser concrete than crushed stone.

In some of the pockets at the joints between two sections the concrete was made in the proportions of one part of cement to two of sand and four of gravel. The reason for making the concrete in these pockets richer was simply a matter of precaution, taken to insure a tight joint, the steel work not fitting together as closely as intended. When the tubes were pumped out no water came through these joints, showing that the 1:2:4 concrete was practically impervious to water, although subject to a hydraulic pressure of about twenty-five pounds to the square inch.

For the purpose of determining the quality of the concrete, 6-inch cores were taken out by means of a Davis calyx drill for the full height of the center wall between the steel tubes. These cores show a remarkable degree of uniformity of the concrete and of high quality, both as to density and strength; in fact, a better grade of concrete was obtained than would be possible in the open air. It should be noted in this connection that this concrete was compressed and set up under a hydrostatic pressure of from sixteen to thirty pounds per square inch, at the top and the bottom of a pocket respectively.

The crushing strength of this concrete when one year old, ran from about 2,800 pounds per square inch minimum, to 4,000 pounds per square inch maximum, for a mixture 1:3:6, according to tests made upon cores taken from the center wall.

It may not be amiss to point out the three essential elements that contributed to the successful results in depositing the subaqueous concrete of the Detroit River Tunnel; they are as follows:

First, dividing the exterior of the tunnel tubes, by means of the longitudinal sheathing and the diaphragms, into compartments or pockets. This produced still water, which is absolutely essential for laying concrete under water, and permitted the filling of one pocket at a time with one monolithic mass of concrete. This arrangement further limited the lateral flow of the concrete, as it emerged from the tremie, to the confine of the pocket and reduced the washing out of cement by water to an absolute minimum, in fact, the loss of cement appeared to be negligible.

Second, the use of an equipment complete in every detail and equal to any demand made upon it, more especially an active or quick acting rig for handling the tremie pipes promptly as occasion required.

Third, mixing the concrete so wet that it would readily flow in the tremies, and the flow controlled by keeping the mouth of the tremie at all times buried in the concrete at a sufficient depth, thereby, at the same time keeping it sealed and preventing the water from rushing in from the outside.

CEMENT PRODUCTION IN 1909.

According to a preliminary estimate of the United States Geological Survey, the production of Portland cement in the United States in 1909 was between 61,300,000 and 62,000,000 barrels, which, valued at 85c. a barrel, was worth at the mills, between \$52,105,000 and \$52,700,000. This represents an increase in quantity of at least 10,227,000 barrels and in value of at least \$8,557,000 over the production of 1908.

DESCRIPTION OF A CONCRETE PRODUCTS PLANT IN IOWA.

By R. H. Klemme, Secretary-Treasurer, Belmond Cement Mfg. Co., Belmond, Iowa.

We have operated our concrete products plant for the past three years and a half, and during that time have shut down only for repairs and to wait for cement shipments that have been delayed in transit. Last fall if we had had a stock of one hundred or more cars of cement tile we could have found ready sale without going farther than twenty-five miles in any direction from our plant. Our building is made of 9 in. block, outside measure 98x100 feet, with a boiler addition 24x36 feet. The curing rooms are ample for eight days' work; our cement supply room holds several cars, and we have a coal storage capacity of about 50 tons of steam nut.

The sand, which is on our property, is bank sand, the bank being about 17 feet deep. We use a dump car and cable to bring the sand to the screens, where it is screened in sizes from $\frac{1}{4}$ in. to $\frac{3}{4}$ in., the gravel being run to the crusher. The screened sand is dumped into a pit whence it is elevated to the mixer, mixed, and then distributed to the various parts of the building for the different machines.

The tile machine is located close to the mixer, for the reason that about 85% of all the concrete used is made into drain tile from 5 to 15 inches. The tile are put on cars and run to the curing rooms. In the year just passed we shipped about 70% of the tile we manufactured. From that amount we sustained a very small breakage and we were able to trace the cause in every case to green tile or tile that should have been in storage another three or four weeks.

Our block, brick and hand tile molds are located in a room 40x100 feet, which adjoins the tile room. In this room we make all the block and brick, besides the special work. We have also used this room to store tile in, in the winter, when the weather would not permit our putting the tile out of doors.

Our equipment for the manufacture of concrete products consists of the following machines: One tile machine, on which we manufacture tile from 4 to 15 inches; block machines that manufacture both single and double air space block from 6 to 12 inches in thickness; brick machine, hand tile mold for the manufacture of tile from 15 to 30 inches; pier, vase and baluster molds.

Our machinery equipment includes Miracle tile molds, a "Positive" mixer, a Schenk drain tile machine, manufactured by the Cement Tile Machinery Co., of Waterloo, Iowa, a Miracle brick machine and Miracle block machines, manufactured by the Miracle Pressed Stone Co., of Minneapolis, Minn.

Our power room is equipped with a 45-H. P. boiler and a 35-H. P. heavy duty engine. We have a dynamo and our own lighting system, switchboard, etc. Our water system is operated by a compressed air tank, having a 3,000-gallon tank under the ground. Water is pumped into the tank and, by using the air compressor, we keep the pressure at about 60 pounds. We also use the air compressor and pneumatic hammers in the manufacture of brick and block.

Our building is heated by the exhaust steam in 1 inch iron pipe radiators and we are able to keep the building at a temperature of about 60 degrees, except in the very coldest weather, when we are compelled to use part live steam.

RECENT ORDERS FOR WE-FU-GO WATER-SOFTENING SYSTEM.

Clean steam generating apparatus is essential for economy. The rational way to have clean heaters, pipe lines, and boilers is to remove from the water the impurities which it contains.

That boiler owners who have bad water to contend with realize that scale and corrosion stand for waste and expense is evidenced by the number of orders for the Scaife and We-Fu-Go Water Softening and Purifying Systems placed with Wm. B. Scaife & Sons Co., of Pittsburgh, Pa., in addition to orders for the We-Fu-Go System for the purification of water for textile, laundry and other uses. Among some of their recent orders are the following:—

Josephine Furnace & Coke Co., Josephine, Pa., 7000 HP We-Fu-Go System.

Friend Paper Co., West Carrollton, O., 4000 HP We-Fu-Go System.

American Sheet & Tin Plate Co., Wellsville, O., 2500 HP We-Fu-Go System.

Aeolian Company, Garwood, N. J., 1200 HP Syphon Continuous System.

Pennsylvania Steel Co., Lebanon, Pa., 9000 HP We-Fu-Go System.

Fayette Coal Co., Noblestown, Pa., 750 HP We-Fu-Go System.

Lawrenceburg Roller Mills Co., Lawrenceburg, Ind., 750 HP We-Fu-Go System.

Fox River Paper Co., Appleton, Wis., 1875 HP We-Fu-Go System.

Davis & Quick, Brooklyn, N. Y., 2000 gallon per hour We-Fu-Go System.

CEMENT MILL NEWS.

A. A. Sutherland, formerly with the Independent Asphalt company, is now sales manager for the Superior Portland Cement company, succeeding Mr. Murphy. (Seattle, Wash.)

* * *

So strong has been the demand for cement by the builders of the state that the two factories in the state of Washington, one at Concrete, owned by the Superior Portland Cement Company, with a capacity of 1,500 barrels a day, and the Washington Portland Cement Company, with a capacity of 900 barrels, have all the orders they can readily handle.

* * *

A mortgage for \$1,500,000 was filed recently covering the property of the United Kansas Portland Cement Company. The mortgage is drawn in favor of the Commercial Trust Company of Kansas City, and it is understood it is for the purpose of funding indebtedness of the company, which has existed ever since the merger of the different plants took place. The original indebtedness was carried in the form of certificates of indebtedness issued to cover the quick assets of the several companies.

Since the panic the cement business has fluctuated to such an extent that the estimates of earnings made when the plants were united has not been realized.

Funds were not available to retire the certificates and as they now draw interest, they constitute a first claim on the earnings of the company.

The mortgage will secure an issue of ten-year bonds. These will be in denominations of \$100 to \$1,000. The money obtained from their sale will be used, it is said, to retire the certificates of indebtedness, clean up other obligations and leave working capital sufficient to push the business. The volume of business is quite gratifying, but the margin to the operating company has proven far from satisfactory.

* * *

George E. Nicolson of Iola, Kan., was elected president of the Iowa Portland Cement Company at the meeting of the directory board. It was announced that by May 1st the new plant at Des Moines, Iowa, will be turning out 3,000 barrels of finished cement per day.

The following officers and directors were elected at the meeting: President, George E. Nicholson, of Iola, Kan.; vice-president, I. F. Crofoot, of Omaha; secretary and treasurer, J. C. Burch, of Des Moines; directors: C. W. Sanford, of Lincoln, Neb.; C. W. Howell, of Omaha; James G. Berryhill, of Des Moines, and L. C. Colman, of La Crosse, Wis.

* * *

Much to the delight of Quincy (Mich.) people, the big cement factory here, which is owned by the Wolverine Portland Cement Co., of Coldwater, Mich., is to commence work again after having lain idle for the past two years. During the past winter the plant has been entirely overhauled and remodeled at an expense of many thousand dollars. About sixty men are now at work getting ready for starting things off

in earnest, and it is expected that by April 1st the entire plant will be set running, employing about 200 men to begin. Prospects are that it will be the biggest year in the history of the plant.

Notice has been given that there has been this day (April 22) filed in the District Court of the United States for the Eastern District of Pennsylvania, at Philadelphia, by John W. Cutler, Walter W. Lee and Frank C. Pringle, a petition in involuntary bankruptcy against Northampton Portland Cement Company, a Delaware corporation, doing business at Stockertown, Pa., and the said petitioners, above named, by their counsel, the undersigned, will on Monday, April 25th, 1910, at ten o'clock A. M., at the Post Office Building, 9th and Chestnut Streets, Philadelphia, make an application to the said court to appoint a Receiver in bankruptcy for the alleged bankrupt and will also ask the court to empower said Receiver in his discretion to carry on the business of said company for thirty days, or until a Trustee is elected, and to borrow such money as he may deem necessary for that purpose, and for such other relief and powers as the court may deem expedient and necessary.

An opinion was filed recently by Vice-Chancellor Howell in a suit brought against the Edison Portland Cement Company by a property owner of Warren county, New Jersey. The plaintiff, who owns a grist-mill of 100 years standing, brought suit to enjoin the cement company from depriving her of the use of the water of the creek by the operation of the cement plant. In denying the allegations in the complainant's bill the cement company supplemented its answer with a cross-bill, praying that the complainant

NEW BOOKS

The Manufacture of Hydraulic Gypsum and Other
Gypsum Products - - - - - 50 Cents

By M. Glasenapp

The Hardening Process of Hydraulic Cement }
The Hardening of Cement Under Water } - 50 Cents Each
The Constitution of Hydraulic Cements }

By Dr. W. Michaelis, Sr.

How to Use Portland Cement - - - - - 50 Cents

Cement Sidewalk Construction - - - - - 50 Cents

Hollow Concrete Building Block Construction - - - 50 Cents

Monier Cement and Steel Construction - - - - - 50 Cents

Handbook of Reinforced Concrete Construction, paper cover 50 Cents

By L. J. Mensch

Delivered Free on Receipt of Price.

Address **CEMENT & ENGINEERING NEWS**
22 Fifth Avenue, Chicago

be enjoined from further proceeding with an action at law begun by her. The petition further asked that it be decreed, in case the complainant be entitled to a writ of injunction, what amount of compensation, if any, should be awarded to the complainant as just and equitable in lieu of the issuance of the writ of injunction prayed for by the plaintiff. Vice-Chancellor Howell, says in part:

The suit in this court is for an injunction to prevent the defendant (Edison Portland Cement Company) from future disturbance of the complainant's right. The common law action is an action for past infractions of the same right. What the defendant is now seeking to do is (1) to stay the suit for past damages; (2) to have it determined by this court whether the defendant is now or has been in the past guilty of a violation of any right of the complainant to flowage of water, and (3) if this court finds that there is such an infraction of the complainant's right that it will ascertain the extent and character thereof and award to the complainant such damages as she may be entitled to, which damages the defendant stands ready to pay.

As a question of pleading, it may be said that the answer must always support the cross-bill. There is a variance between them in this case which must count strongly against the defendant. The answer denies all the injury complained of, while the theory of the cross-bill is that the defendant is committing a continuous trespass on the rights of the complainant, and that it desires to continue the same trespass indefinitely, and to pay therefor such sum as this court may assess.

If the defendant is guilty of the charge laid to its door, it is depriving the complainant of a valuable right in the waters of the creek, and this right is property to which the complainant is entitled.

Shortly then, the case under the cross-bill takes upon itself the aspect of an attempt to take private property for private uses upon such compensation being made as this court may award. This, of course, is not to be thought of. There is no proceeding known to the law by which one man can take the property of another for the private use of the taker, no matter what rate of compensation may be offered. This would be an interference with vested rights and can not be permitted.

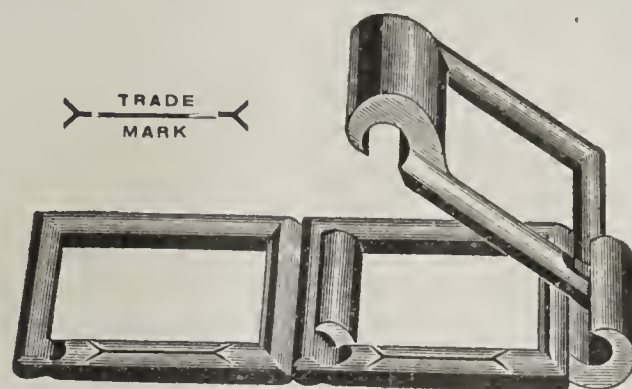
It will be observed that there is no contract between these parties upon which the cross-bill can be predicated, nor is there any equity alleged by which the bill can be supported, except that the jurisdiction invoked may be exercised to prevent a multiplicity of suits. I do not understand that the doctrine touching the power of this court to interfere with a multiplicity of suits extends to the case made by the cross-bill. In short, what the defendant says is this:

"I am committing a most flagrant disturbance of the right of the defendant for which she is suing me. I desire to continue my trespass and to enjoin her suits for damages, not because I have any right in her land, but because she is bringing actions to defend the title to her property, which I want and am willing to pay for."

Laches was also set up in the cement company's answer, and concerning this the vice-chancellor says:

The fact that the complainant lay still, and made no complaint for a period of two years during which time the defendant took water from the stream, may have been sufficient laches to have justified the court in denying to her the provisional relief which she sought, but is she to be deprived of the title to her estate because she did not bring suit immediately upon the beginning of the trespass?

Original "Ewart"



Detachable Link-Belt

and our other approved chains, attachments, etc., described and illustrated in Link-Belt Catalog No. 75 A

> Flint-Rim < Sprocket Wheels FOR DURABILITY



Trade Mark—Reg. U. S. Pat. Office.

Made to Fit the original "Ewart" and other chains of our manufacture.

Cost but little more than ordinary cast iron wheels.

Prompt shipment follows every order.

ASK FOR BOOKLET.

LINK-BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

NEW YORK, PITTSBURGH, ST. LOUIS,
299 Broadway, 1501-2 Park Bldg. Central Nat'l Bank Bldg.

SEATTLE, DENVER,
439-440 N. Y. Block, Lindrooth, Skubart & Co.

NEW ORLEANS,
Willmot Machy. Co.

SAN FRANCISCO—Eby Machinery Co.

Allis-Chalmers No. 21 Rock and Ore Breakers

"THE LARGEST BREAKERS EVER BUILT"

These breakers are designed to fill the demand for machines with a large receiving opening and for use in crushing plants producing large quantities of crushed stone. They are proportioned so as to obtain the maximum of strength and rigidity.

Write for Description, Prices, etc.

GENERAL
OFFICES

ALLIS-CHALMERS CO

MILWAUKEE
WISCONSIN

IRON-ORE CEMENT

The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in place of Portland cement for all Marine Construction.

Send for Literature, Etc.

Worm-Cox Company
SOLE AGENTS

Marquette Building, Chicago

SPECIFY

Tisco Manganese Steel

FOR

Ball and Tube Mill Linings,
Gears, Pinions, Sprockets, Chain

IT LASTS LONGEST

TAYLOR IRON & STEEL CO.

HIGH BRIDGE NEW JERSEY

Peerless Portland Cement

MANUFACTURED AT UNION
CITY, MICH.

**Every Barrel
Guaranteed**

Fineness, Uniformity of Color
and Sand Carrying Qualities
equal to any Portland Ce-
ment Manufactured

**German-American Port-
land Cement Works**

OWL CEMENT

Illustrated Pamphlet Mailed on Request

E. L. COX, General Sales Agent,
1527 Marquette Bldg.,

Works: La Salle, Ill. CHICAGO

MEACHAM & WRIGHT CO.

Sales Agents

IMPROVED

UTICA HYDRAULIC CEMENT

And Dealers in

LEHIGH PORTLAND CEMENT

Telephone 206 La Salle St. Chicago
Main 59

F. D. MEACHAM, Pres.
S. P. BLOUNT, Treas.

F. S. WRIGHT, Vice-Pres.
C. M. FOSTER, Secy.

Improved Canvas Stitched Belting



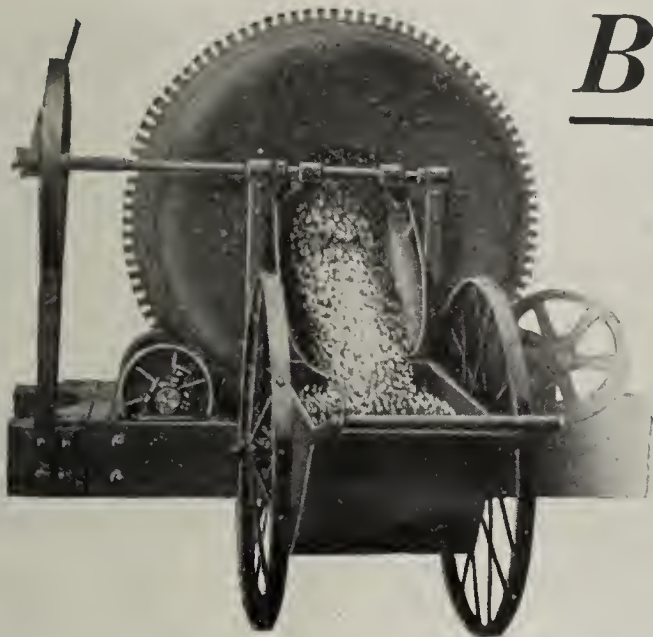
We Specialize in making Belts
for use in Cement Plants.

Light or Heavy Transmission,
Elevator or Conveyor Belts for
Wet, Dry, Hot or Rough condi-
tions.

Sawyer Belting Co.

Cleveland, O.

Send for Book "K."



Batch Discharged Instantaneously

In buying a concrete mixer, the method of discharging is a vital question.

You don't want a mixer that "tea-spoons" the batch out in little dabs, and—

Neither do you want a mixer that has to stand on its head to disgorge. Persons not thoroughly acquainted with the **facts** might be led to think that in order to avoid the "tea-spoon" type of mixer, it is necessary to get one of the turn-upside-down variety. Nothing of the sort!

The Ransome Mixer

does not "tea-spoon" its batch in discharging, neither does it **tilt**. It is as guiltless of the one weakness as the other.

The Ransome Blades which **lift** the material and accomplish the discharge are **not** short, dinky blades—not the "tea-spoon" variety! On the contrary, they extend clear across the drum, and as the drum revolves, the entire contents are **lifted** and hurled into the discharge chute with great rapidity. The discharge is **instantaneous**.

The Ransome Blade arrangement which effects **rapid mixing** and **quickest discharging** is a distinct Ransome feature. It is fully protected by many patents and cannot even be remotely imitated.

Furthermore, the Ransome revolves continuously in one fixed position, ready to **receive** or **discharge** its batch **instantly**. It **never tilts**.

Instead of inverting the whole machine, we merely **lower the chute** and the discharge is accomplished **automatically** and **instantaneously**.

Tilting means **lost motion—time wasted**—both in tilting and recovery of the machine to normal position—**The Ransome saves that time**.

The Ransome makes a clean, thorough discharge of its batch in one-fifth the time consumed by the imitation cylindrical drum mixer and in vastly less time than the best tilting type of mixer ever made.

The Ransome discharges its batch in less than ten seconds.

Time saved in getting the materials **in** and **out** of the mixer is a **great saving** in **labor cost** and it will pay you to get at the **real facts**—send for our hand-book of concrete-mixing information. Just say "*In the Wake of the Ransome*," and we'll know what you want.

William B. Hough Company

"Where The Good Contractors' Machinery Comes From"

Indianapolis Detroit Chicago Des Moines Minneapolis

*Large Stock carried in
our Chicago Warehouses
for immediate shipment.*



**Main Office:
Chicago. U. S. A.**

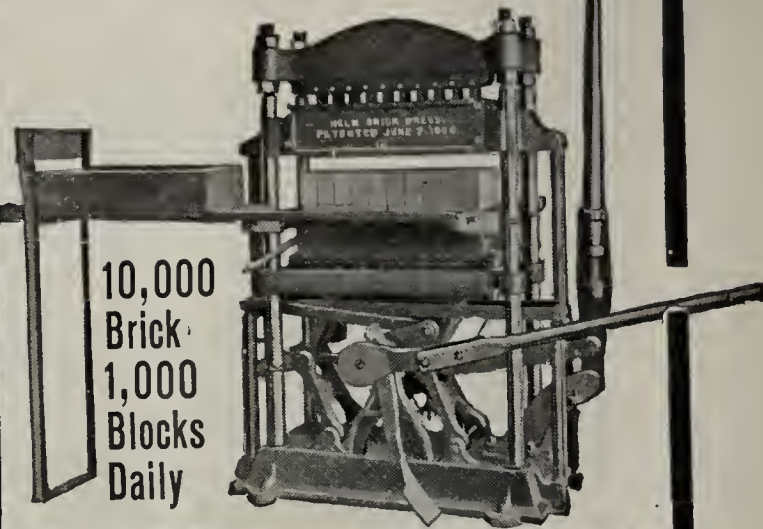
BIG MONEY FOR YOU

In Pressed DRY-WALL Blocks and Brick

Helm Presses make as high as \$50.00 daily. You can secure the cream of the concrete business with their superior product. Unequalled for beauty, strength, adaptability and cheapness. Daily displacing machines of every description.

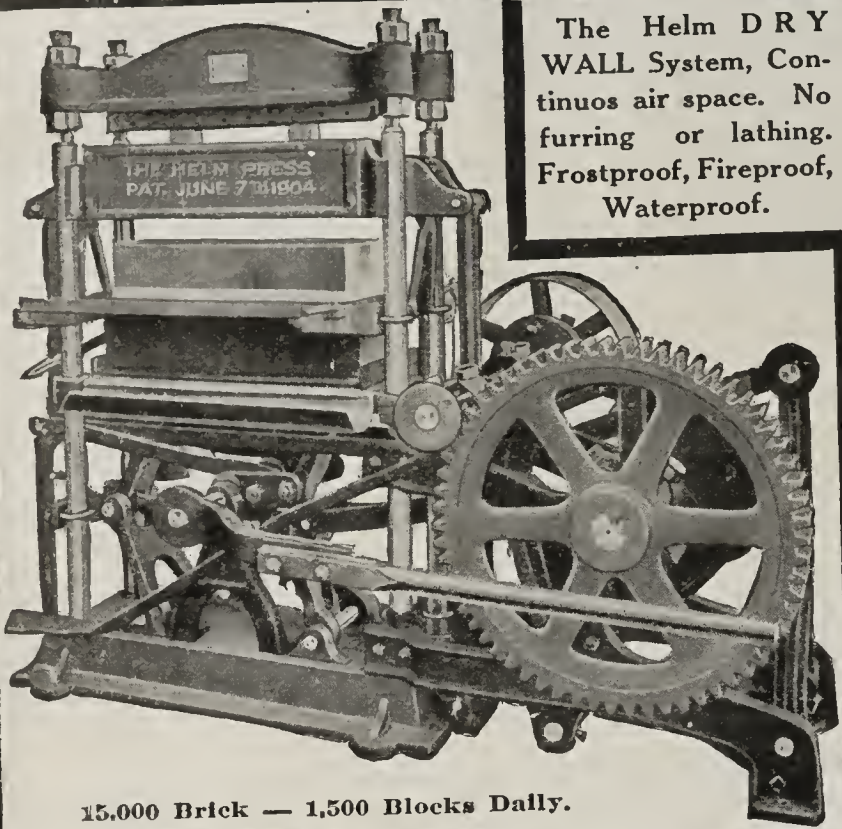
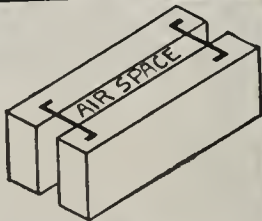
The 80,000 lbs. pressure of Helm Brick and Block Presses make the strongest and most uniform concrete product. A 6 to 1 brick only 27 days old stood 85,000 pounds compression, for excelling all other tests. Heavy pressure on medium wet concrete secures this wonderful result with the least cement. A Helm Press and the medium wet mix is the only sure and certain method. You're bound to adopt it in the end. You'll save money by adopting it now. No "extras" to buy with Helm outfits.

80,000 lbs.
Pressure



10,000
Brick
1,000
Blocks
Daily

The Helm DRY
WALL System, Con-
tinuous air space. No
furring or lathing.
Frostproof, Fireproof,
Waterproof.



15,000 Brick — 1,500 Blocks Daily.

Investigate the Helm Hand and Power Presses

if you want to control the big contracts in your locality. You can outstrip competition. You can manufacture cheaper, make better product and get better prices and more business.

Send the Coupon for free Concrete Book

Profusely illustrated with half-tones and diagrams of machines, product and building forms. Shows how to secure dry walls. Don't buy without first getting this book. Send the coupon right now for your copy, free and prepaid.

HELM BRICK MACHINE COMPANY,

Traverse City, Mich.

214 Bank Building,

HELM BRICK MACHINE COMPANY,

214 Bank Bldg., Traverse City, Mich.

Send me the free book on concrete. Interested in ☐ Blocks,
Brick. ☐ Mixers. ☐

NAME

ADDRESS

PATEK'S CONCRETCOTE

INSIDE AND OUTSIDE FINISH FOR CONCRETE.

This special concrete finish waterproofs concrete, and is practical to use under all working conditions, unaffected by dampness, gases, smoke, oil, etc. Gives uniformity of color to concrete, covering joints, dirt streaks, etc. Concretcote does not crack, peel or blister.

A PERFECT, PRACTICAL STAIN FOR THE EXTERIOR OF STUCCO AND CONCRETE HOUSES.

WALLS—Wall Concretcote is the only remedy for saltpetre trouble. Recommend it and figure it on your jobs, and you will avoid the difficulties encountered when saltpetre comes in contact with oil and water paints.

FLOORS—Floor Concretcote penetrates the concrete deeply and evenly, seals the pores and amalgamates with the material, forming a moisture proof surface. Gives an elastic, linoleum-like surface, non-porous and washable, which resists the pulverizing of cement by heavy traffic.

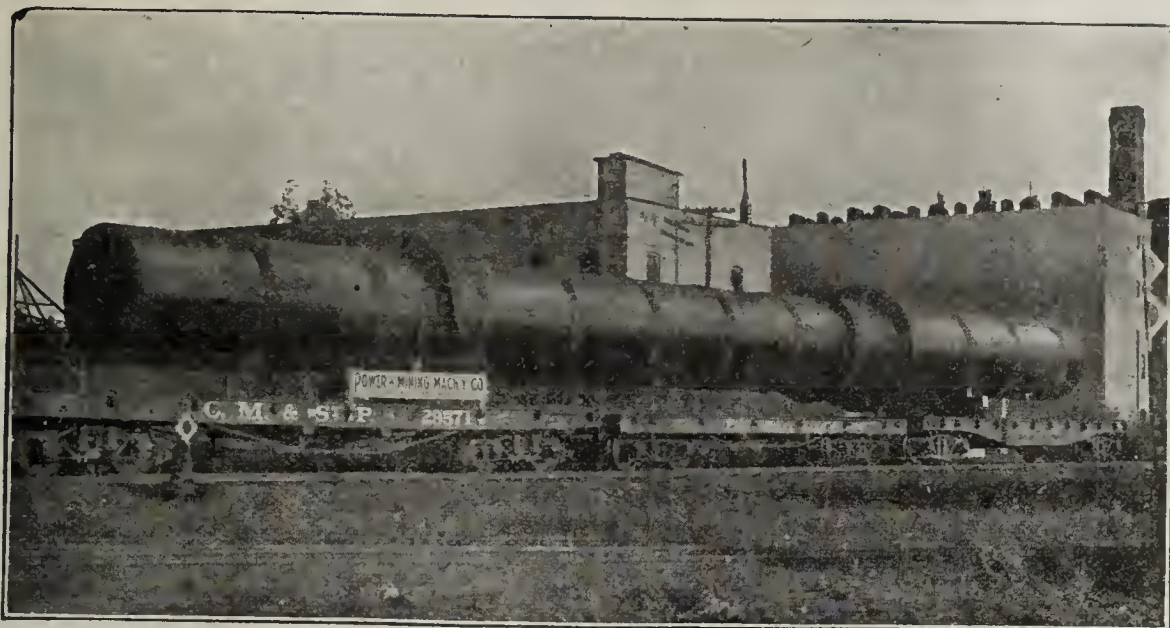
Write For Free Booklet Showing Colors.

PATEK BROTHERS, Sole Makers, MILWAUKEE.

Cement Mill Machinery

A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process.

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



Write for Catalogue No. 17.

Power & Mining Machinery Company

MILWAUKEE, WIS., U. S. A.

CHICAGO.

NEW YORK.

ATLANTA.

EL PASO.

SAN FRANCISCO.

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

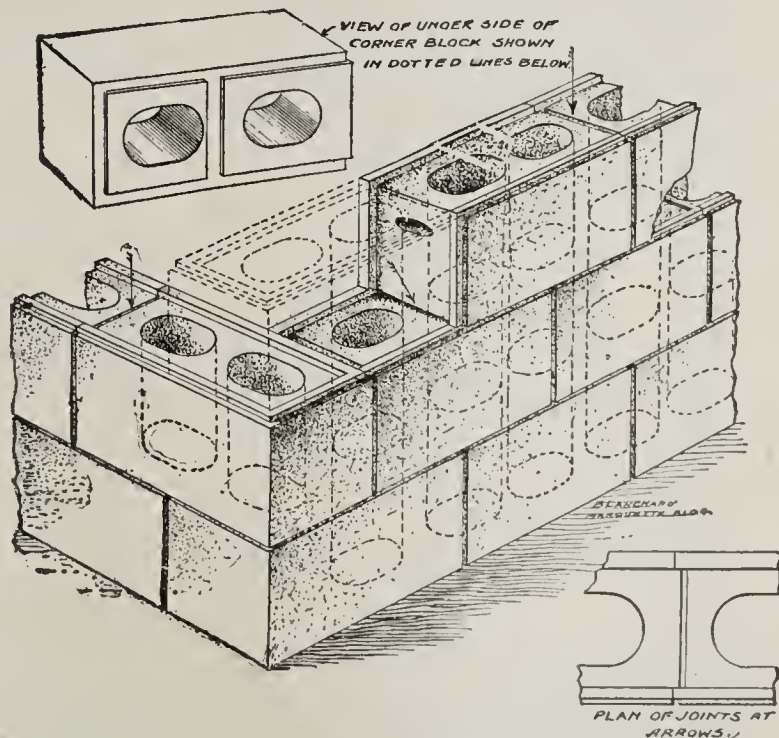
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting Face-Down Machine by the Wet Process

The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and agents wanted in all states and foreign countries.

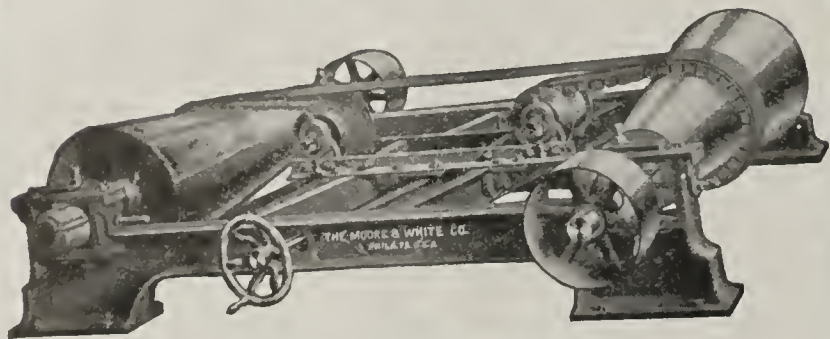


DIAMOND CONCRETE MACHINERY COMPANY

Tacoma Building,

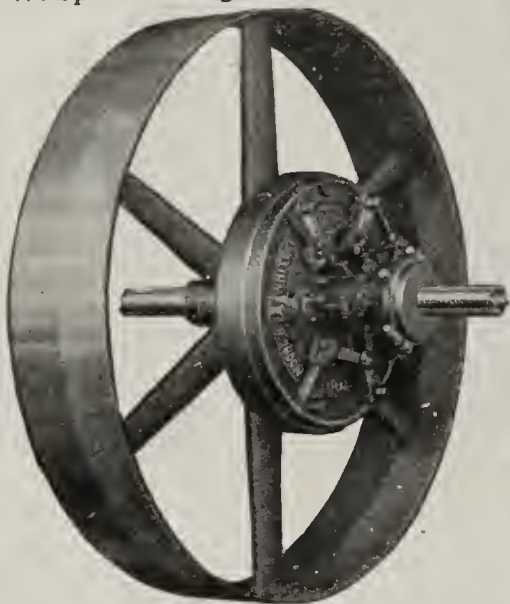
Chicago, Illinois

It will be to any Mill Owner's advantage to investigate these two economical Power devices.



M. & W. Speed Change.

Power
Transmission
Machinery
for
Cement
Mills.



Friction Clutch Pulley.

Write for
Catalogue.

The Moore & White Co.,
Philadelphia, Pa.



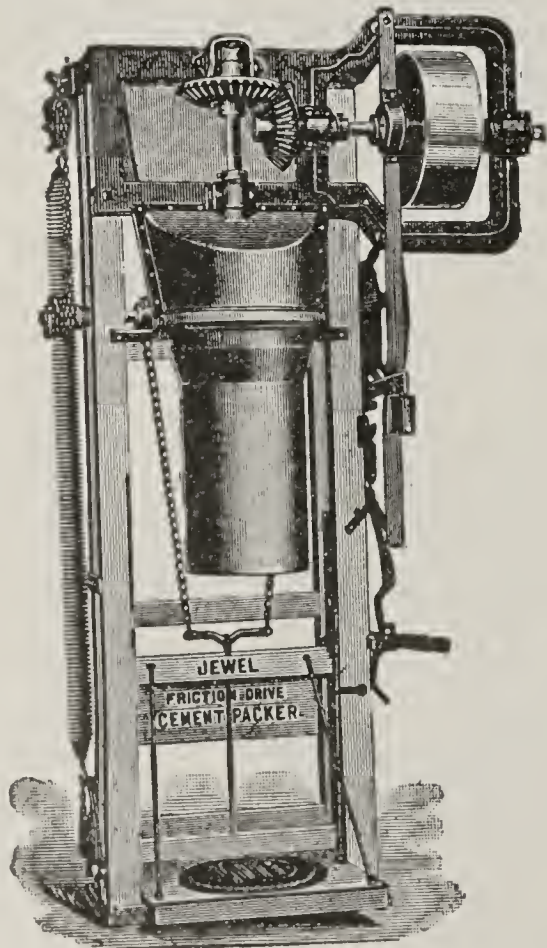
Promptness
in shipments is of vital importance to the cement user whose storage capacity is usually limited and whose work is so frequently dependent upon weather conditions. The big output of this Company, our enormous storage bins, the location of our mills near large centers of population where abundant labor may be had, where large car supplies are available, where connections with the numerous railroads entering Chicago and Pittsburg can be made readily—an efficient Traffic Department service—these form the basis of our reputation for quick shipments.

Universal Portland Cement Co.

Chicago—Pittsburg

Annual Output 8,000,000 Barrels

There is more Cement being packed by the "S. HOWES" Company's Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and sacks.

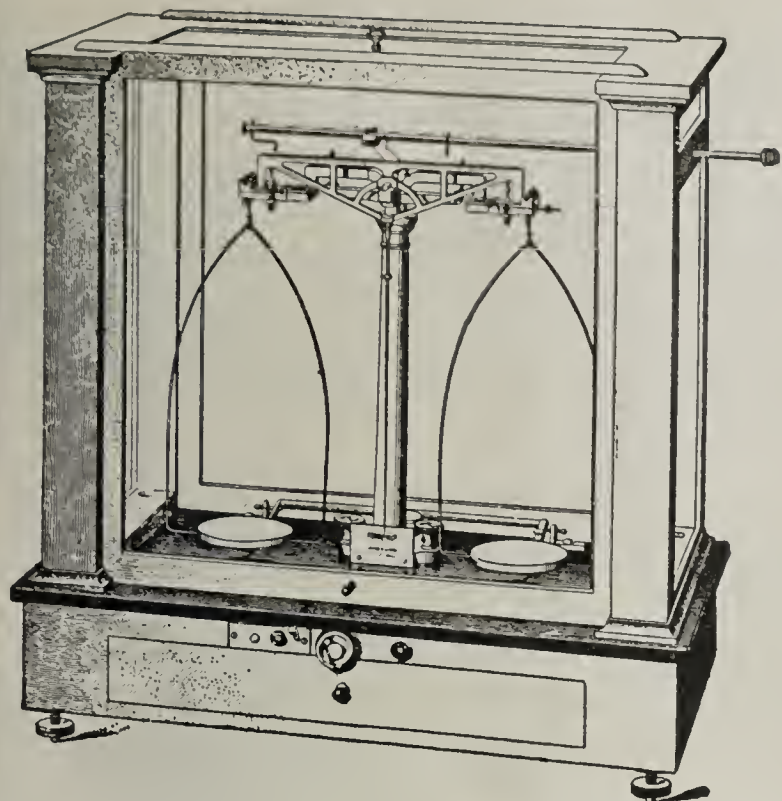
The "JEWEL" FRICTION driven cement Packer, specially constructed for rapidly packing sacks.

Both machines are equipped with friction pulleys, heavy iron frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company
SILVER CREEK, N. Y.



Apparatus for Chemical and Physical Testing of Cement

EIMER & AMEND

205-211 Third Avenue, New York City

MANUFACTURERS OF & HEADQUARTERS FOR

Chemical Apparatus, C. P. Chemicals and Reagents*Cement Briquette Moulds.**Gilmore Needle.**Standard Sieves of Exact Meshes.**Williams' Sp. Gr. Balance.**Specially adapted for determining
Sp. Gr. of Cement.**(Descriptive Pamphlet sent on request)**Schumann's, Le Chatelier's,
Jackson's and Candelot's
Apparatus for Sp. Gr. of
Cement.*Headquarters for **Calorimeters and Pyrometers.***(Our large illustrated Catalogue gladly sent to Chemists on application.)***F. A. Jones, M. E.****Gypsum Specialist**Consulting Mechanical, and Chemical Engineer, in
Designing Construction, and Operation of Plaster Mills,
Mines, and Mixing Plants.Plans, Specifications, Estimates of Cost, Superinten-
dence of Construction, ROTARY or KETTLE PROCESS.Examination, Tests, Analysis, and Reports of Gypsum
Properties, Mills Remodeled and Enlarged, Mixing
Plants Erected, and Formulas Furnished.

883 Mahoning Avenue

YOUNGSTOWN, OHIO**WM. B. SCAIFE & SONS CO.**

221 First Ave., Pittsburgh, Pa.

WE-FU-GOand **SCAIFE**

Water Softening, Purifying, and Filtering Systems

— FOR —

BOILER FEED

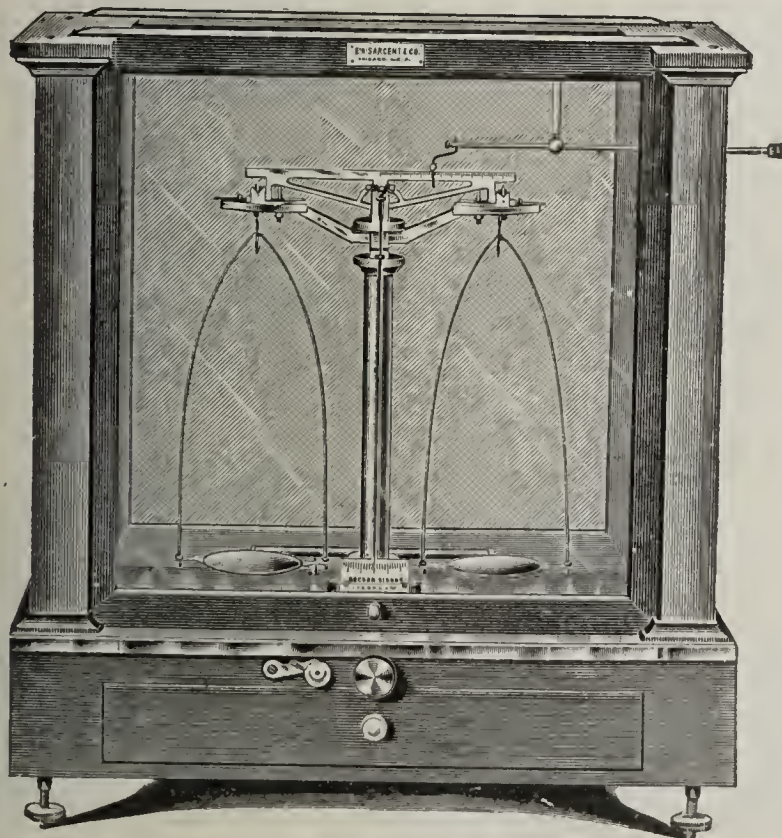
AND EVERY INDUSTRIAL USE.

Send for Complete Information

DEXTER Portland Cement
THE NEW STANDARDSole Agents **SAMUEL H. FRENCH & CO.** Philadelphia**HAVE YOU AN IDEA?**If so write for our books: "Why Patents
Pay," "What to Invent," "100 Mechanical
Movements" and a Treatise on Perpetual
Motion—50 illustrations. All mailed free.**F. G. DIETERICH & CO.** Patent Lawyers
and Experts

501 Onray Block

WASHINGTON D. C.

**E. H. SARGENT & CO.**

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN

CHEMISTS SUPPLIES

Of high grade only.

We call particular attention to our Cement
Mould, Vicat Indenting Apparatus, as im-
proved by us, Gilmore's Needles, Jackson's
specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

CHICAGO



McCaslin Conveyor over Storage Bin Handling Hot Clinker

The McCaslin Conveyor

Acknowledged by Competent Engineers as the best Conveyor in the world for handling hot clinker, stone, etc., in **CEMENT PLANTS.**

Low Cost of Maintenance Absence of Shut Downs
Maximum of Efficiency

Manufactured solely by

Mead, Morrison Mfg. Co.

BOSTON

NEW YORK

CHICAGO

Catalog on Request

Send Us Your Specifications for an Estimate

Face Your Blocks

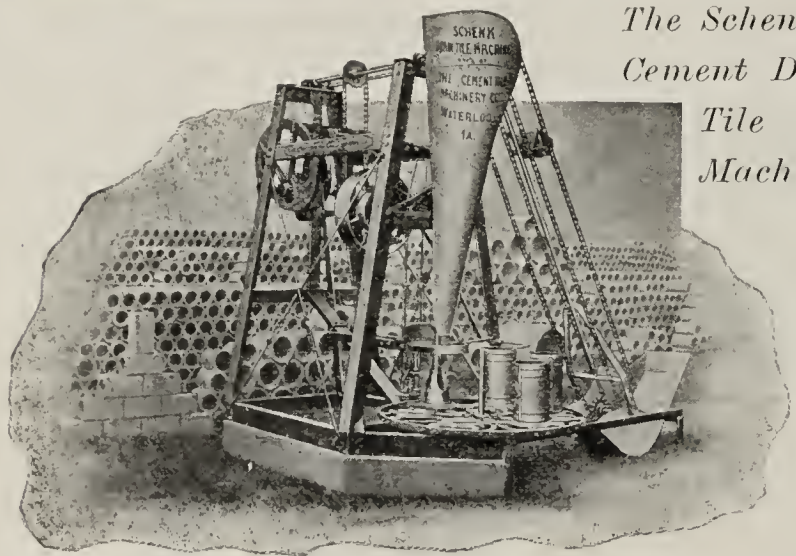
Make Them White

Do You
Use

WHITE SAND

Leading contractors specify our pure White, Washed and Screened Silica Sand for fine work in ornamental stone, block facing, porch work, ornamental lawn fixtures, vases, etc.
This sand is shipped both DRY and DAMP.
Prices and Samples on request.

BALLOU'S WHITE SAND COMPANY
MILLINGTON, ILLINOIS



*The Schenk
Cement Drain
Tile
Machine*

"Money in Cement Tile"

We have just published a little book with this title; it tells the whole story in a way you will understand.

Write for it today.

The Cement Tile Machinery Co.
WATERLOO, IOWA

Portable Elevators

FOR HANDLING

**Stone, Gravel
and Cement**

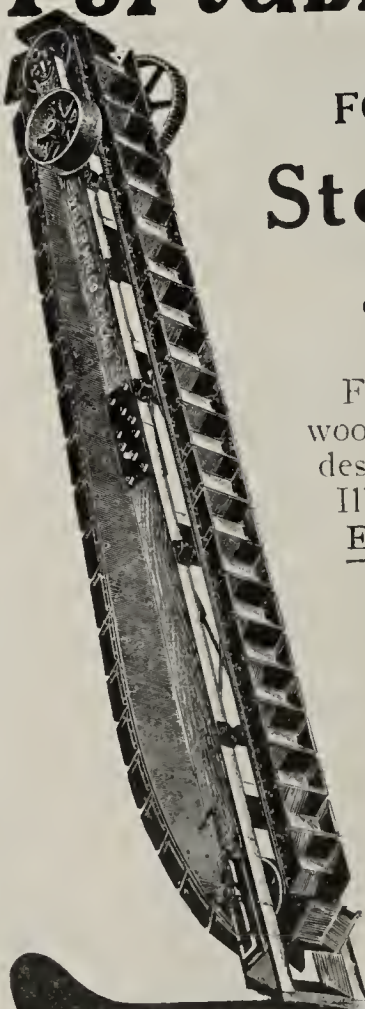
Furnished in all designs, with wood or iron frames, and of any desired capacity.

Illustration shows a WELLER-Made Portable crushed stone elevator; we furnish these for handling all classes of materials.

Send for 512 page catalog on WELLER-Made Elevating, Conveying and Power Transmitting Machinery.

Weller Mfg. Co.

CHICAGO



WELLER-Made

The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa

WANT COLUMNS.

Advertisements in this column are inserted at the rate of two dollars per inch per issue—and no advertisement will be taken for less than two dollars and must be paid strictly in advance.

POSITION WANTED.

Assistant Chemist (Lehigh University), desires position. Am also a first class accountant. Four years' experience. Address Chemist, 330 Fourth St., South Bethlehem, Pa.

WANTED.

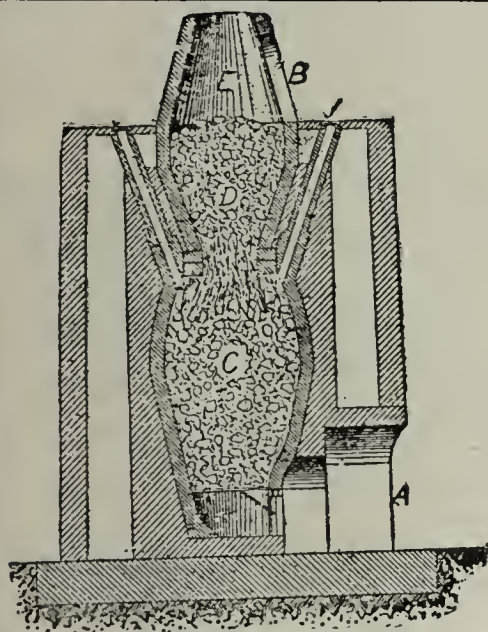
If you are interested in pumps of latest and best styles, send to us for book and catalogue. Pumps of all styles and for all uses. The Columbus Steam Pump Works, West Broad street, Columbus, Ohio.

WANTED.

Position as asst. chemist by a young man with four years practical experience and a good technical education. Address B., care Cement & Engineering News.

CHEMIST having some years experience, is open for a position with a cement company. References furnished. Address O. C., care Cement and Engineering News.

CHEMIST—With 8 years successful and extensive experience as chief chemist desires change of location. References from present and past employers. Address L. G., care Cement & Eng. News.



The Kiln & Chimney Construction Co.

197 HAVEMEYER STREET
BROOKLYN, N. Y.

We build Kilns for burning Lime and Cement, also

CHIMNEYS

REPAIRING and REMODELING
our SPECIALTY

WANTED.

We want to buy at once several second hand concrete building block machines. Also a second hand tamping machine. Address V. L. S., care Cement and Eng. News.

"PLASTER OF PARIS"

American Patent No. 757649 dated April 19th, 1904.
FOR SALE.

This method produces a much better quality than other methods and there is a great saving in the cost of production. The German Patent has been sold and the process can be seen working in England. Apply DUNN BROS. & CO., Manchester, England."

Location for Cement Plant

Extensive Deposits of Raw Material. Proximity to Large and Growing Markets. Low-Priced Fuel Supply.



THERE ARE several desirable locations for Portland Cement Plants along the Santa Fe, where the advantages enumerated are to be found. If you are interested you can secure full and detailed information by addressing this office.

The SANTA FE is glad at all times to co-operate with those seeking locations or desirous of investigating conditions in territory tributary to its line. Correspondence from interested manufacturers is invited.

WESLEY MERRITT, Industrial Commissioner A., T. & S. F. Ry.
1122 Railway Exchange Building
CHICAGO, ILL

The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker
1½ inches diameter from the kiln
and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

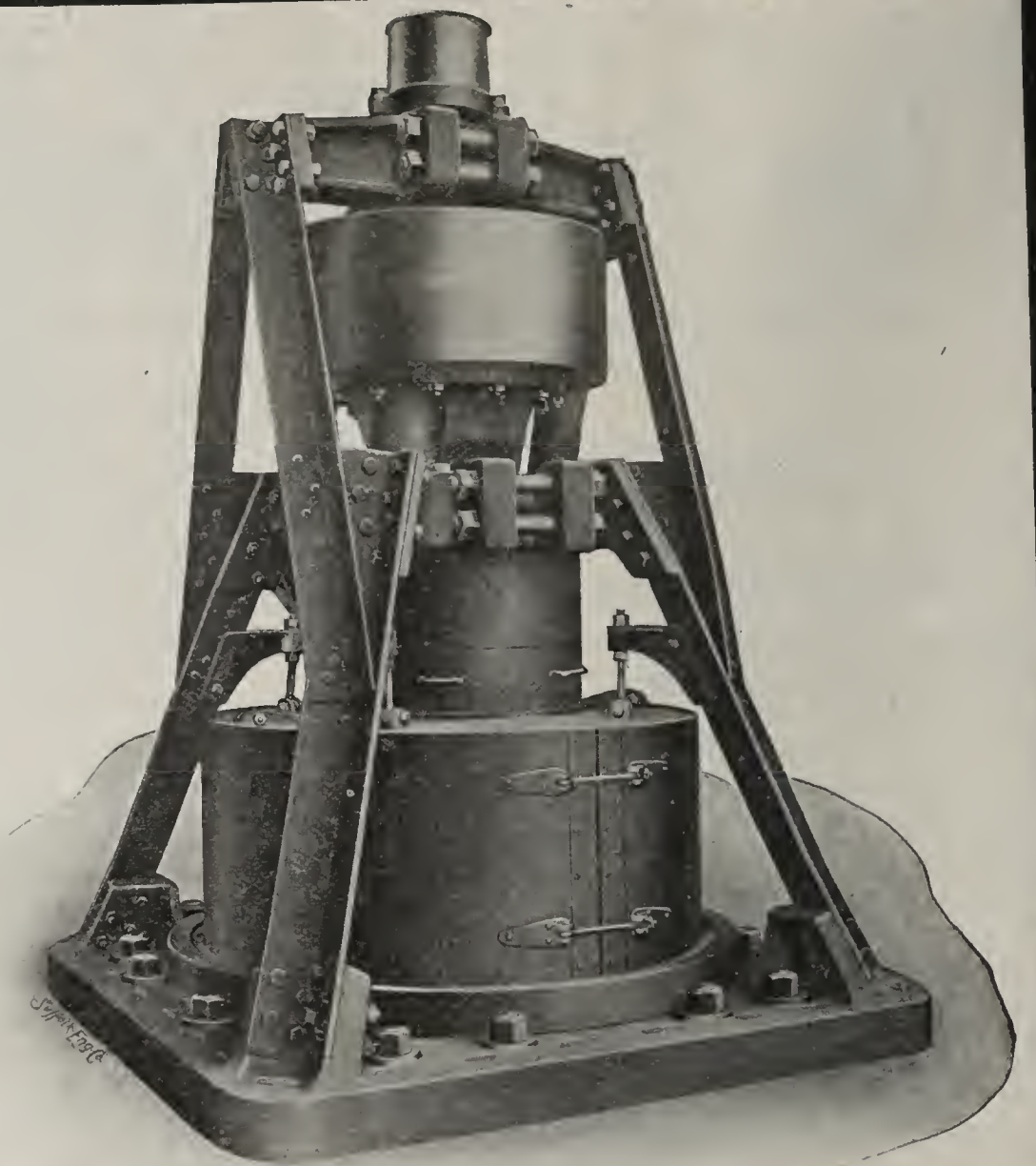
It saves cost in attention.

MANUFACTURED BY

BRADLEY PULVERIZER CO.

37 Walbrook
LONDON, E. C.

92 State Street
BOSTON



ALPHA

PORTLAND CEMENT....

Alpha, N. J.
Works: Martins Creek, Pa.
Manheim, W. Va.
Alsens, N. Y.

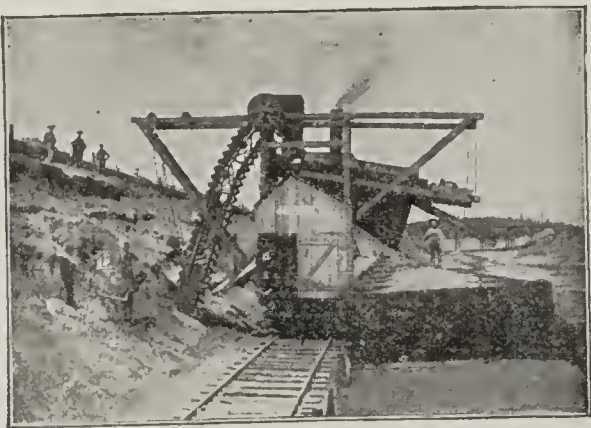
Quality
unexcelled

The Recognized Standard
American Brand

Always
Uniform

ALPHA PORTLAND CEMENT CO.

Manufacturers of but one grade—strictly straight Portland
General Office, EASTON, PA.



JEFFREY

Excavating and
Screening Plants

FOR

Earth, Sand, Gravel, etc.

It does practically all the
digging and handles from
50 to 60 tons per hour.

Elevating and Conveying Systems for handling Coal,
Stone, Ores, Sand, etc.

Jeffrey A5 Electric Rotary Drill

Is a serviceable and thoroughly efficient Machine for Drilling Coal,
Slate, Clay, Gypsum, Etc., fully described in Bulletin Aa 16.

Send for Catalog Series Aa, and state your requirements

The Jeffrey Mfg. Co., Columbus, Ohio

New York
Chicago
Boston

Pittsburg
St. Louis
Denver

Buffalo
Charleston, W. Va.
Montreal, Can.

LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GRIND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.,
ALLENTOWN, PA.

Western Office:
725 ROCKEFELLER BUILDING,
CLEVELAND, OHIO.



THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

Design, Construction, Remodeling and Operation
of Portland Cement Plants

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street
New YorkCanadian Express Bldg.,
Montreal, Can.1121 The Rookery
Chicago425 Washington St.
San Francisco, Cal.Monongahela Bank Bldg.
PittsburghSyndicate Trust Bldg.,
St. Louis, Mo.Norfolk House, Cannon St.
E. C., London

The Osborn Engineering Co. Civil, Mechanical and Electrical Engineers

OSBORN BUILDING, CLEVELAND, O.

Experts in the Designing of
CEMENT PLANTS.

Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of Cement Machinery

42 NORTH 16TH STREET

:::

PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

COMMERCE BLDG.,
Kansas City, Mo.

Cement Engineers

Just Out!

Architects' and Engineers' Hand Book on
Reinforced Concrete
Construction

ONLY ONE DOLLAR
CEMENT & ENGINEERING NEWS

22 Fifth Avenue, - - Chicago

Colonial Trust & Savings Bank

A BANK FOR THE PEOPLE

Pays 3% on Savings Accounts

Capital and Surplus, \$1,106,620

YOUR ACCOUNT INVITED

205 La Salle Street, - - - - - Chicago, Ill



THE IMPROVED DIETRICH'S CLAMP and

Form System for Hollow Walls

By the use of the Improved Dietrichs Clamp and Form System for Hollow Walls the

COST OF CONCRETE CONSTRUCTION IS REDUCED 50%

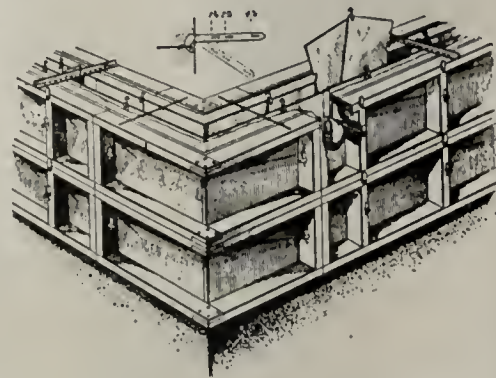
and the builder also secures a

PERFECT DAMP-PROOF WALL

This system is based on the panel principle and employs removable sheet iron inner forms with sheet iron spacer. Corners, doors and window openings are provided for.

Write for pamphlet giving full information

DIETRICH'S CLAMP CO.
LITTLE FERRY, N. J.



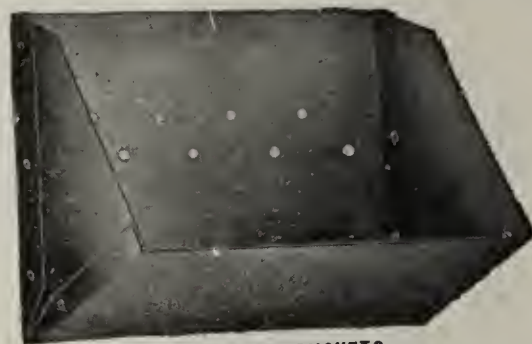
ELEVATING-CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys, Shafting, Shaft Bearings, Link Belting, Special Chains



HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES.
Catalog for the asking.

SKILLIN & RICHARDS MFG. CO., CHICAGO

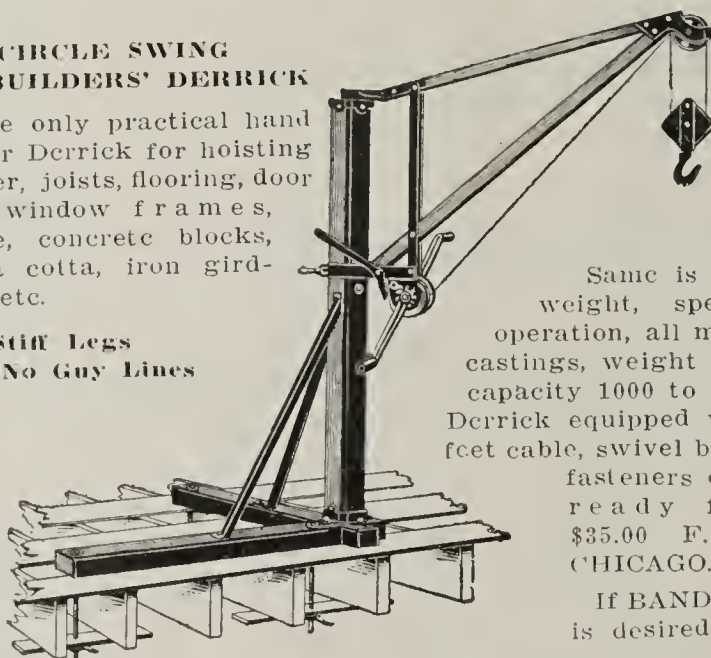
THE SASGEN BUILDERS' DERRICKS

The Latest Inventions in
HOISTING APPARATUS

Our CIRCLE SWING BUILDERS' DERRICK

is the only practical hand power Derrick for hoisting timber, joists, flooring, door and window frames, stone, concrete blocks, terra cotta, iron girders, etc.

No Stiff Legs
No Guy Lines



Same is light in weight, speedy in operation, all malleable castings, weight 250 lbs.; capacity 1000 to 1500 lbs. Derrick equipped with 110 feet cable, swivel block and fasteners complete ready for use \$35.00 F. O. B. CHICAGO.

If BAND BRAKE is desired, add \$1

We keep all these machines in stock and can fill orders promptly.

SASGEN BROS.

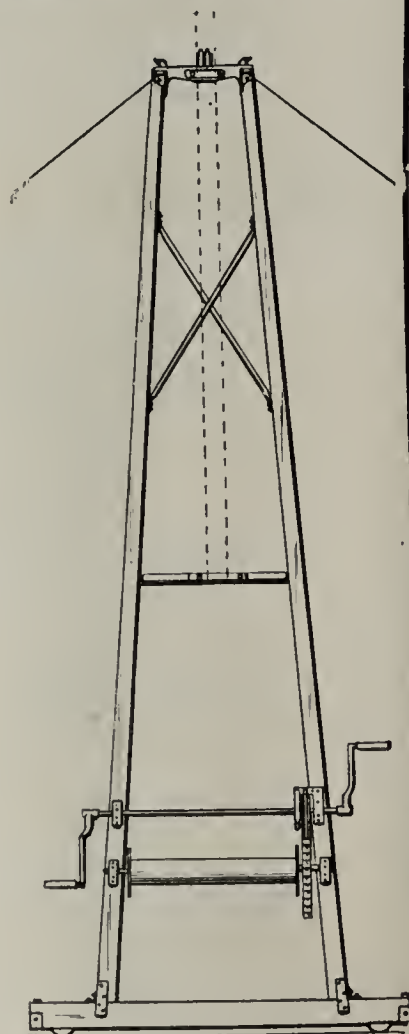
2053-57 Racine Ave., - - - CHICAGO, ILL.

New York Office, 103 Park Ave.

Write for Illustrated Catalogue "C"



OUR POLE DERRICK is built light and strong. Average length 18 ft.; weight 200 lbs.; capacity 1800 lbs.; equipped with 100 ft. cable block and rollers ready for use \$26.50 F. O. B. Chicago.



OUR SASGEN IMPROVED SETTER DERRICK including a top shive frame, extension clamps, etc. Price of 20 ft. lengths \$42.00 F. O. B. Chicago.

N

Porch Column and Pier Outfit

Jobbers and Dealers Wanted



Looks well on any house, hundreds in use
Concrete specials bring **BIG PROFITS.**

If you don't own a Porch Column Outfit you
are not getting the most out of your business

Concrete Machinery Bargains

Sill and Cap Mould.....	\$11.50
Chimney Moulds.....	5.25
Block Machines.....	10.00
Hand Mixers.....	22.00
Power Mixers.....	50.00
Brick Machines.....	18.50
Tile Moulds.....	6.25
Silo Machine.....	10.00
Ball Moulds.....	2.55
Gasoline Engines.....	40.00

Everything Sold by the Pound

Send for big 1910 catalog
which describes dozens of
different block machines,
brick machines, ornamental
moulds, silo machines, hand
and power mixers, tile
moulds, post machines, ball
moulds, in fact everything
that may be desired in this
line. It will save you money.

We make everything in the Concrete Machinery Line.

Northwestern Steel and Iron Works

Box 810 EAU CLAIRE, WISCONSIN

N

Medusa White Portland Cement

Used for entire exterior plaster of
Ritz Hotel, San Francisco,
Cal., here illustrated.

A beautiful product adapted to
ornamental artificial stone work
of the highest grade. Equal or
superior to any other White Port-
land Cement known.

Write for free sample, pamphlet
with instructions for use and price.



MEDUSA WATERPROOFING

(Patented Apr. 23, 1907)

Makes concrete impervious to water and prevents ef-
florescence and discoloration. Gives absolutely perma-
nent results and does not affect strength, setting or
color of Portland Cement.

Used by nearly all the foremost Engineers, Architects,
Railways, Contractors, Block Makers and Cement
Experts.

Obtain our price and circular, also price on Medusa
Gray Portland Cement.

SANDUSKY PORTLAND CEMENT Co., Sandusky, O.



"EXPENSES DIMINISHED"

"MEANS PROFITS INCREASED"

ROCK CRUSHERS.

1—9 x 15 Allis Chalmers Jaw Crusher.

ROCK DRILLS.

6—Ingersoll-Sargeant Rock Drills, size
3 1/4 inches.

6—Ingersoll-Sargeant Rock Drills, size
3 1/2 inches.
Fitted for steam or air.

HOISTING ENGINES.

1—12x16 double cylinder, heavy duty
LIDGERWOOD hoisting engine.

1—6x8 Marine Iron Works double cy-
linder, single drums, reversible in
steam chest.

PUMPS.

3—24 inch Centrifugal pumps, 2 to
3,000,000 gallons capacity.

1—20x13x12 Wheeler & Tappan Duplex
Pump.

IRON PIPE.

70,000 ft. 1 inch Standard Pipe, 35,000
ft. 1 1/4 inch Casing.

50,000 ft. 1 1/2 inch Standard Pipe, 40,000
ft. 3 1/4 inch Casing.

30,000 ft. 2 inch Standard Pipe, 60,000
ft. 3 1/4 inch Casing.

2,000 ft. 10 inch Standard Pipe, 8,000
ft. 5 1/2 inch Casing.

4,000 ft. 12 inch Standard Pipe, 9,000
ft. 6 1/4 inch Casing.

30,000 ft. 8 inch Cast Iron Pipe, 1,000
ft. 6 1/2 inch Casing.

300 ft. 24 inch Cast Iron Pipe, 1,250
ft. 8 1/4 inch Casing.

1,500 ft. Riveted Steel Pipe, 24 inch to
72 inch diameter.

ROOFING MATERIAL.

The latest and most modern product
ever offered to the public. Our "Raw
Hide Rubber Roofing" is without equal
in durability and price. Will outlast the
kind you have been using from 10 to 15
years and will cost you less. Is fire and
weather proof. Send for our special book
No. 180 on roofing; tells you all about it.

5,000 rolls rubber, leather and canvas belting, structural iron, shafting, pulleys, couplings, steel wire and manila rope. Smoke
stacks, corrugated roofing and siding, hose hydrants, tanks. We can save you money on anything you require.

SEND FOR OUR NEW 500-PAGE CATALOG NO. 962.

A wonderful book of facts and information of the utmost value to everyone. Send to-day. It will cost you nothing.

CHICAGO HOUSE WRECKING CO., 35th and Iron Sts., CHICAGO, ILL.

A CAREFUL COMPARISON OF OUR
STOCK AND PRICES WILL DEMON-
STRATE A SAVING TO YOU OF FROM
30 TO 75%.

SEND YOUR INQUIRY TO-DAY.

TANKS.

12—1,000 gallon capacity tanks.

42—1,500 gallon capacity tanks.

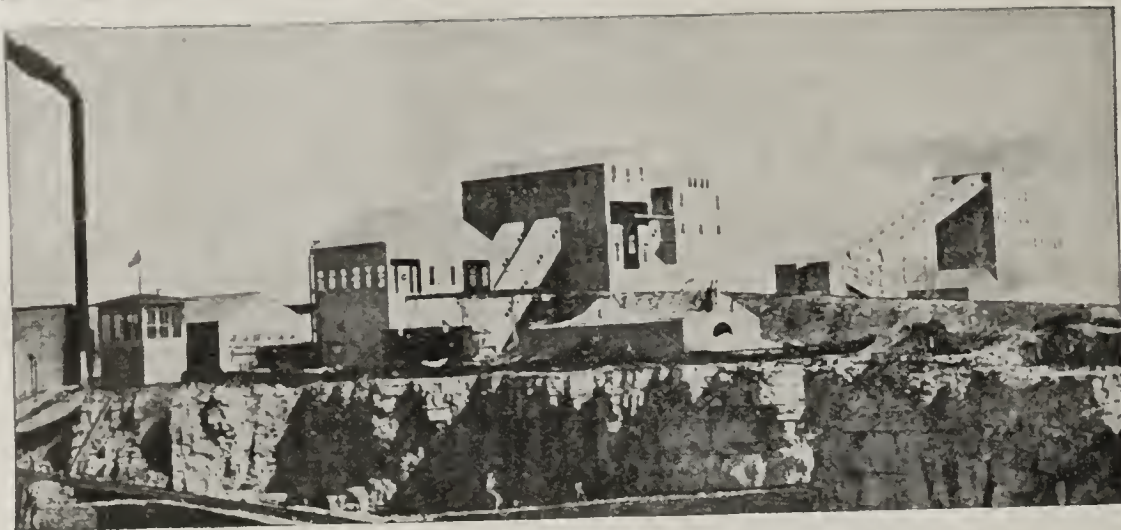
6—3,000 gallon capacity tanks.

15—3,600 gallon capacity tanks.

2—3,800 gallon capacity tanks.

STEEL STORAGE TANKS.

Capacity, 4,500 to 6,500 gallons. These
tanks were used only a short time in
railroad service. Very heavy construc-
tion—1/4" steel with 5-16" heads; domes in
proportion to size of tank, and fitted with
15" serewed manhole. We will give
them rigid inspection and paint before
shipment. Prompt shipment can be made
from points South, East and West.



Dolse & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world. Machinery throughout installed by us.

OLSON BROS. & CO.

Engineers and Contractors

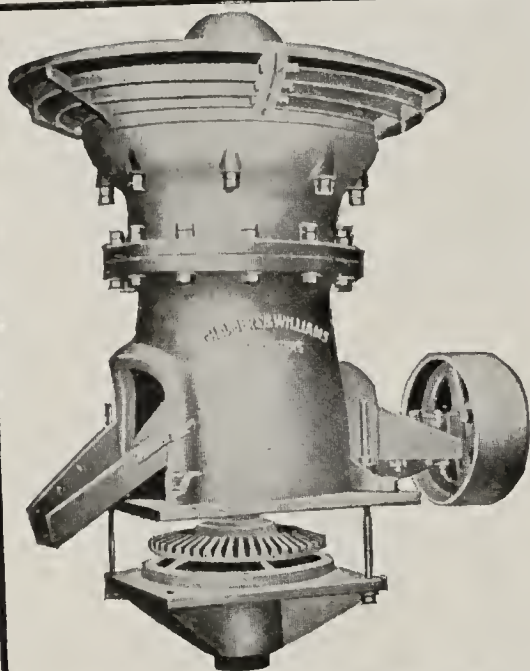
Cement Mill Machinery Erected, Stone Crushing
Plants Equipped and Erected. :: :: ::

ALSO COMPLETE PLANTS FOR HANDLING
COAL, SAND, GRAVEL, ORES, ASHES, ETC.

MODERN POWER TRANSMISSION
Elevating and Conveying Machinery.

Tanks and Vats, Especially in Connection with Machinery

2418-22 Bloomingdale Ave., Chicago



Kennedy Gyratory Crusher

The only Crusher built with a ball and socket eccentric which will lend itself to any change in the inclination of the main shaft. Improved hopper, more efficient dust collars.

— ALSO —

Cement Making Machinery

Kilns, Dryers, Tube Mills, Ball Mills, Elevators, Conveyors, Feeders,
Revolving Screens and Crushing Rolls.

Chalmers & Williams Inc.

1927 Commercial National Bank Building, - - - Chicago
120 Liberty Street, New York



TRADE MARK

PENINSULAR PORTLAND CEMENT

Acknowledged by competent Architects and Engineers
to be unequalled for fineness, wonderful development
of strength and sand carrying capacity.

"THE BEST IS THE CHEAPEST"

Address

Peninsular Portland Cement Co.
JACKSON, MICHIGAN.

Fire Brick Linings For Cement Kilns

STANDARD TESTING SAND AND
GENERAL BUILDING SUPPLIES

Garden City Sand Co.,
188 Madison St., Chicago

Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - - - 645 No. Sixth St., Terre Haute, Ind.

Channon's New Catalog No. 50

**of Contractors' Machinery
and General Supplies**

Ready for Distribution

Send for it

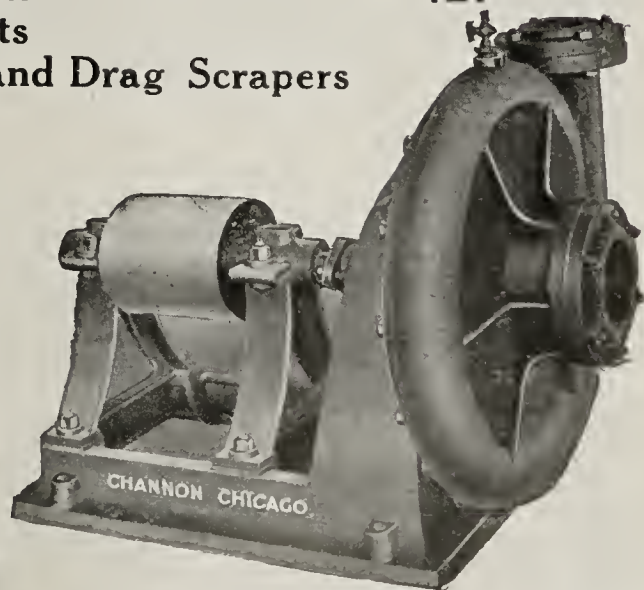


Mundy Hoisting Engines

This catalog describes machinery and general supplies of all kinds for contractors, bridge builders, cement plants, quarries, mines, mills, machine shops and other industries. This is a valuable book giving weights, prices, etc., and is sent without charge to those interested.

Here are a few of our Contractors' Specialties :

Channon Rotary Scraper Excavators
Hadsel Slack-Cable Scraper Excavators
Mundy Hoisting Engines
Channon Derrick Irons
 " Concrete Mixers
 " Material Elevators
Hayward Orange Peel and Clam Shell Buckets
Stuebner Concrete and other Hoisting Buckets
"K & J" Cars, Wheelbarrows, Carts, Wheel and Drag Scrapers
 and Plows
American Saw Mills
Witte Gasoline Engines
Cameron Simplex Steam Pumps
Channon Centrifugal Pumps
Channon Diaphragm Trench Pumps
 and a Complete Stock of
Hand Tools, Jacks, Shovels, Rope,
 Blocks, Etc.

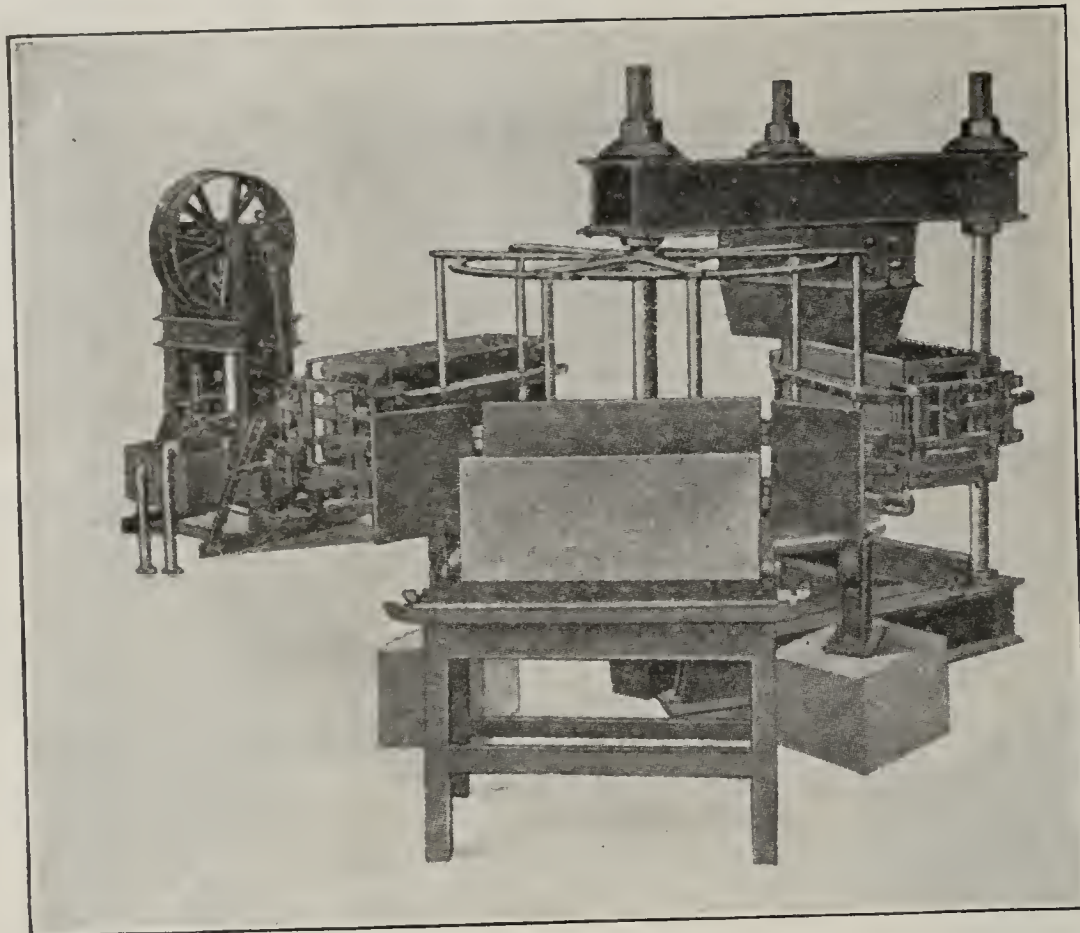


Channon Centrifugal Pumps

H.Channon Company.

Manufacturers **Chicago** Selling Agents

A DENSE CONCRETE



A Hydraulic Ram Pounding Concrete Into Blocks

TWO MEN do the work. From 1000 to 2000 blocks per day. Three quick-acting mold boxes rotating over the Ram on a Revolving Table, one being filled, one receiving the pounding, one delivering the finished block.

The Fisher Hydraulic Machine pounds a wet mixed mortar together with a Hydraulic Ram and produces a dense concrete with less than 5% absorption, with a high crushing strength, in any style to suit the demand.

Ask for Catalogue or any information regarding our system.

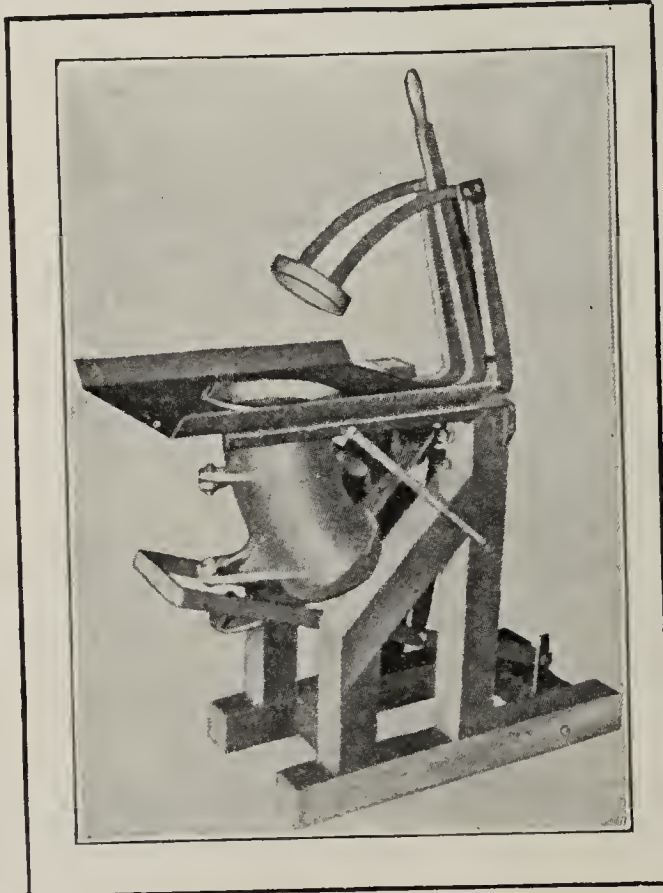
Fisher Hydraulic Stone & Machinery Co.

Builders' Exchange Building, Baltimore, Md.

Concrete Sewer Pipe Bends

The Only Machine
of Its Kind
on the Market.

Concrete Sewer Pipe
Bends Made on the
**RICKMAN SEWER PIPE
BEND MACHINE** Make
Money for the Manu-
facturer.



The Latest Thing
Added to the Concrete
Machinery Line.

ONE MAN can make from 15 to 20 curved sections of pipe per hour. Shovel in the material, tamp it with the tamping ring, operated by foot lever, attach the bell-end form, complete the section, withdraw core from below, by lever, carry the pipe away to a pallet and bring the outer mold back to the machine.

You Need This Machine to Complete the Equipment of Your Tile Factory

Write for Circulars and Prices

R. L. RICKMAN CO.,

987 Westminster Avenue,
VANCOUVER, B. C.

Why Don't You?

Make Your Own Cement in the manufacture of SILICATE BRICK and STONE out of Sand, Slag, Quarry-Waste, or any silicious material, with a small percentage of Lime.

Our "DIVISION-METHOD" will produce a higher grade product at a lower cost than can be made under any other process.

"RAW MATERIAL TO FINISHED PRODUCT—24 HOURS."

We furnish all Machinery, erect complete Factory and turn it over in perfect running order.

Write for full particulars to

International Sand-Lime Brick & Machinery Co.

90 WEST STREET, NEW YORK CITY

ENGINEERS AND CONTRACTORS FOR SILICATE BRICK AND STONE FACTORIES.

The Right Power For Concrete Workers

YOUR engine is in the I H C line. For you want greatest efficiency, combined with economy, simplicity, strength and durability. Your engine must work hard, in all kinds of weather, under the most trying conditions. That is why

I H C Gasoline Engines

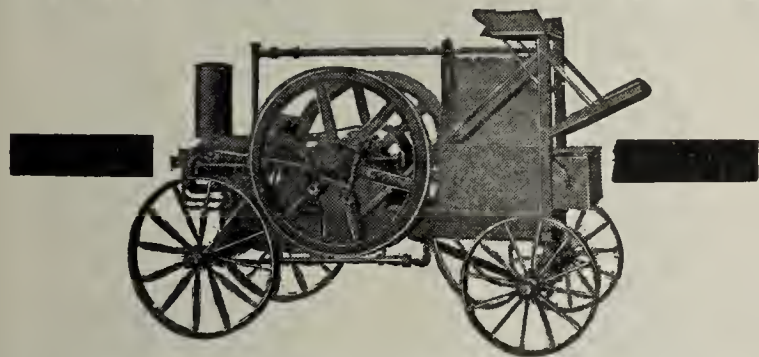
have been the choice of concrete workers who want the right power. See the local International agent about the I H C engine to meet your requirements. Any horsepower, vertical or horizontal, stationary or portable, air or water cooled, mounted on skids or trucks. Catalogue and full information from agent or direct from us.

International Harvester Company of America

41 Harvester Building.

INCORPORATED

CHICAGO, U. S. A.



CHARLES F. McKENNA, Ph. D.

Inspection of Cement

and all other Engineering Materials. Examination of Properties and of Economical Operation of Works.

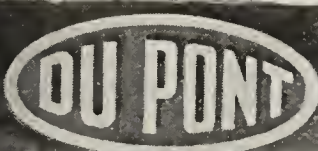
Consulting and General Practice in Chemistry, Technology, Chemical Engineering and Chemico-Legal Cases.

Long Distance Telephone.

Cable Address: PLAT PEARL

Laboratories: 221 Pearl St., New York City

Offices: 50 Church Street




OFFICES

BIRMINGHAM
BOSTON
BUFFALO
CHICAGO
CINCINNATI
DENVER
DULUTH
HAZLETON
HOUGHTON
HUNTINGTON
JOPLIN
KANSAS CITY
MEMPHIS
MEXICO CITY
NASHVILLE
NEW ORLEANS
NEW YORK
PHILADELPHIA
PITTSBURG, PA.
PITTSBURG, PA.
PORTLAND
SALT LAKE CITY
SAN FRANCISCO
SCRANTON
SEATTLE
SHREVEPORT
SPOKANE
SPRINGFIELD
ST. LOUIS
TERRE HAUTE

JUDSON POWDER

is an explosive ranking between blasting powder and dynamite. It is invaluable in many kinds of work.

1802
1910





E. I. DU PONT DE NEMOURS POWDER CO., Wilmington, Del., U.S.A.

COPYRIGHTED BY E. I. DU PONT DE NEMOURS POWDER COMPANY, 1910

Hotel Cumberland

NEW YORK

S.W. Cor. Broadway and 54th St.

Near 50th Street Subway Station and 53d Street Elevated

HEADQUARTERS FOR THE CEMENT AND MACHINERY MEN.

New Modern Fire Proof

All Outside Rooms. No Carpets. All Oriental Rugs.

Transient Rates \$2.50 with Bath and up.

10 minutes walk to 20 theatres.

Send for Booklet.

HARRY P. SIMPSON, Formerly with Hotel Imperial

R. J. BINGHAM, Formerly with Hotel Woodward

SELECTED WHITE SAND

For.

Ornamental
Concrete
Stone



For.

Hard
Plaster
Finishing

Cement
Block
Facing

Exterior
Plastering

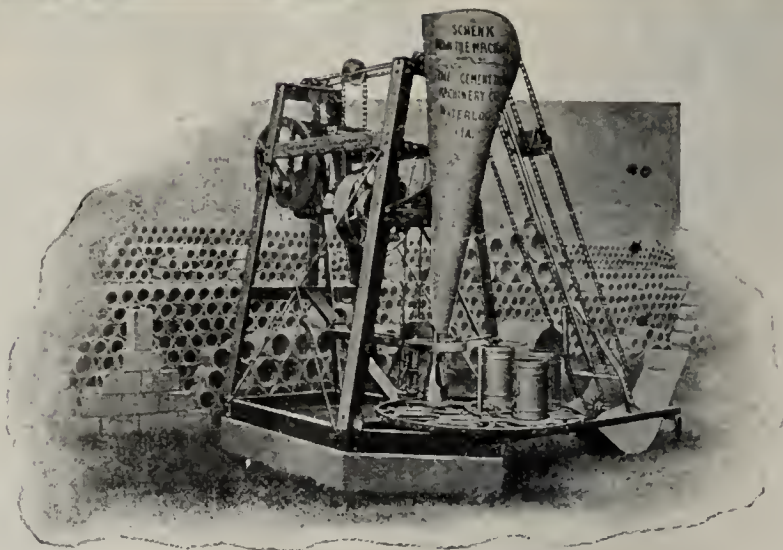
Stone & Marble Sawing

Shipped in paper lined box cars or 150 lb. bags

UNITED STATES SILICA CO.

1041 AMERICAN TRUST BLDG.

CHICAGO



The Schenk Cement Drain Tile Machine

is conceded by all who are familiar with the concrete machinery business to be absolutely the most perfect and the most successful machine in the field; upon its merits the cement drain tile industry has been built; and on account of its success other machines have been constructed, but no machine at the present date surpasses the Schenk Machine for capacity, durability, convenience, economical operation and for satisfaction.

We sell the Schenk on an Iron Clad Guarantee, backed by the largest exclusive concrete machinery manufacturers in the world.

Our free catalog, "Money in Cement Tile" will give you interesting information relative to the proper equipment, the construction of buildings the amount of capital required, the amount of profit to be expected; in fact, it tells how to start a plant for the manufacture of cement drain tile and just what you will be able to realize on your investment.

Write for it today.

The Cement Tile Machinery Co.
WATERLOO, IOWA

THIS POWERFUL AUTOMATIC BLOCK MACHINE

Makes 1000 Blocks 24"x12"x9" in 10 Hours.

Each block receives **20 TONS** "SQUEEZE" twice from opposite directions.

Ours is the only 1 piece, double air space, building block on the market.

WESTERN SHAW BLOCK CO.

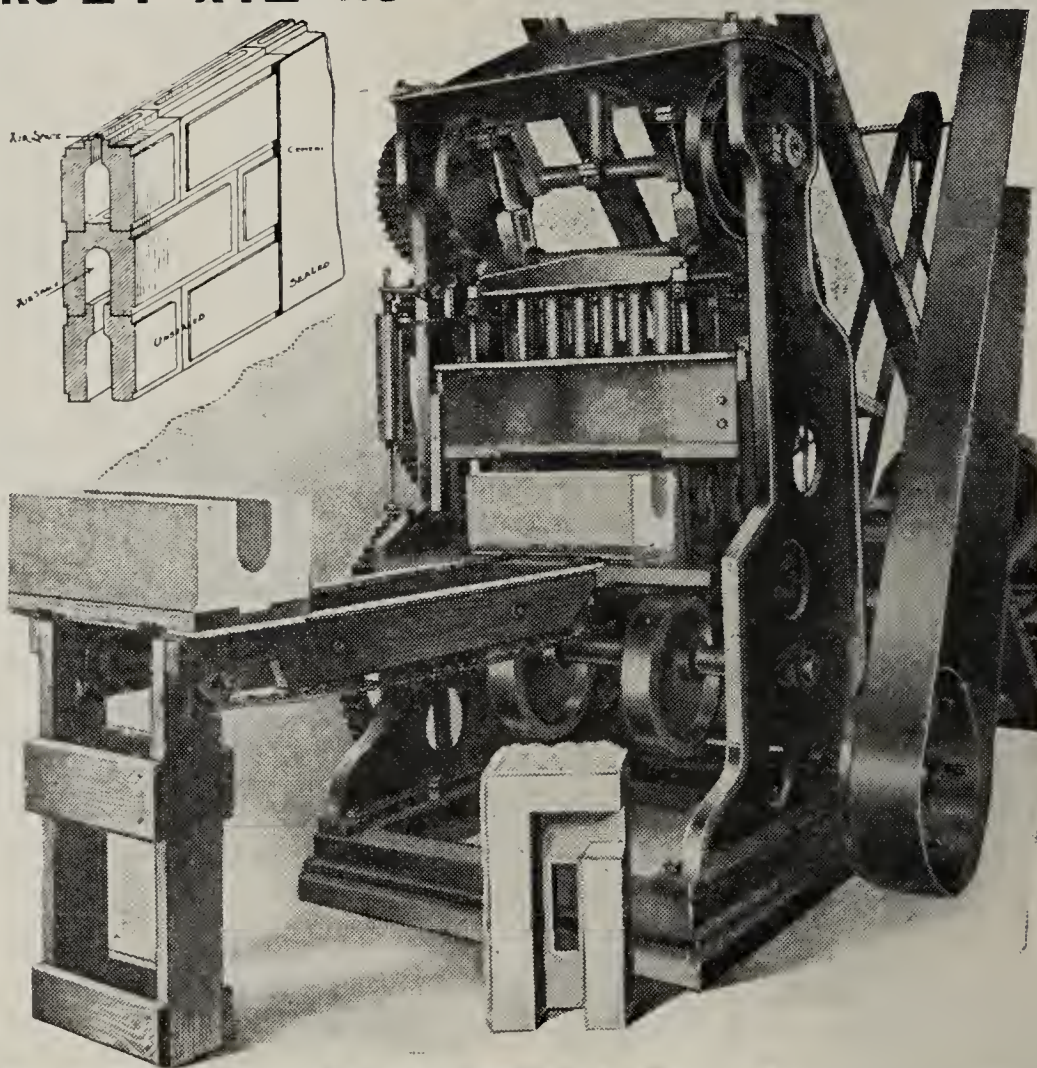
Room 317

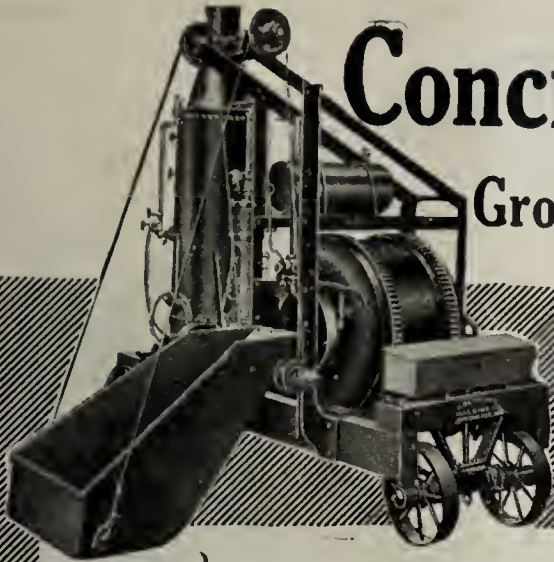
218 LA SALLE ST., :: CHICAGO, ILL.

Our terms permit you to pay for the machine with a small per cent of your profits.

With this plant you can successfully compete with common brick, and be independent of the competition of any other building block machine.

Consult your own interest and get in on this live proposition.





Concrete Mixer Theories

Grow Into Definite Mixing Knowledge

When Every Mixing Action Is A
Known, Positive Mechanical Force



There's An Individuality About Koehring Mixing—It's Known Mixing

The drum is a plain cylinder with heavy cast iron heads, but, bear in mind, it's made without *deflecting faces* or other *obstructions* to limit the *end-to-end* mixing.

The mixing blades are so arranged that they not only *lift and pour* the aggregates from the side but carry them alternately from *end-to-end* and *break them over* against the heavy heads.

There's no *guess-work* about it—no rolling over in the center of the drum—every action of the aggregates is performed by a *known, positive mechanical force*.

But there's another mixing than this in the Koehring Mixer.

—When not in discharge position, the inner end of the discharge chute is tilted downward.

—Material carried up by the mixing scoops at the side is discharged onto the inwardly and downwardly extending chute and descends from the inner end in a *continuous flow*, the entire width of the chute, and falls to the bottom at *right angles*, to that from the *mixing scoops* and the *end-to-end* mixing.

That's *three independent mixings*, every one of them a *known mixing* and no *theories* required to explain them.

Three known mixings in one, is why the *Koehring Mixer* is the *fastest in existence*.

But known mixing is not its only improvements over old style batch mixers.

—The trunnion rollers are cast with *wide faces*, *chilled* to extreme hardness and placed wide apart at the extreme ends of the drum.

This not only guarantees a *stable equilibrium* to the drum but insures its maintaining *perfect alignment* even after years of service. The outer end of the discharge chute does not tilt downward, affording ample clearance for wheelbarrows, even in the *smallest sizes*.

There are other *worth considering* features, that every mechanical mind *knows* are correct in principle, explained in our new catalog. Do not fail to write for it at once, being sure to mention "*Catalog B*."

KOEHRING MACHINE CO., 614-616 GERMANIA BUILDING
MILWAUKEE, WIS., U. S. A.



NONE JUST AS GOOD

THESE BOOKS are intended to be read by everyone who intends building. It makes no difference what you are going to build, you cannot afford to consider building without considering concrete as a building material. You cannot afford to consider concrete without knowing about

ATLAS PORTLAND CEMENT

BOOKS IN THE ATLAS CEMENT LIBRARY:

Concrete Construction about the Home and on the Farm	Free
Concrete Houses and Cottages, Vol. I—Large Houses	\$1.00
Concrete Houses and Cottages, Vol. II—Small Houses	1.00
Concrete in Highway Construction	1.00
Reinforced Concrete in Factory Construction, delivery charge	.10
Concrete in Railroad Construction	1.00
Concrete Cottages	Free
Concrete Country Residences (out of print)	2.00
Concrete Garages	Free

Write for any or all of them to

The **ATLAS** Portland CEMENT Co.

Dept. D, 30 Broad Street, New York

Largest output of any cement company in the world.
Over 50,000 barrels per day.

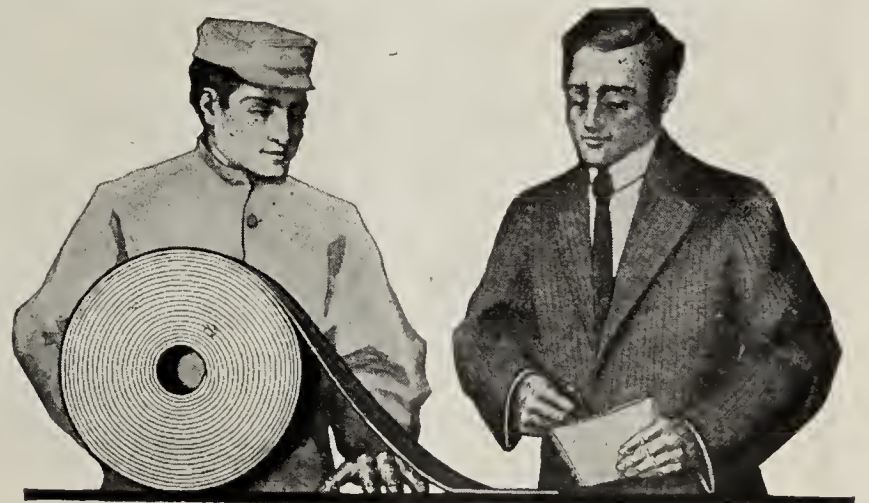


FIGURE THE COST

If one Reliance belt lasts twice as long as two ordinary belts and costs only a trifle more to *buy*, besides giving greater efficiency, needing few if any repairs and causing no trouble, which is the most economical belt to use?

RELIANCE Guaranteed Leather Belting

is the highest quality made. We recommend it especially

For Cement Plants

where it does the severest work without stretching or quickly wearing out. Our broad experience will prove of value to any manufacturer seeking utmost durability and efficiency. Where a waterproof belt is necessary Sea Lion will prove highly satisfactory—we *guarantee it*.

Write for Booklet.

Chicago Belting Company

12-22 Green St., Chicago

Branches: New Orleans, 431 Gravier St. New York, 71 Dey St.
Portland, Ore., 94 First St. Philadelphia, 234 North Third St.



"Safest to use, because richest in Bitumen"

"Pioneer"

OUR asphaltic products were first introduced in 1896. For 14 years they have been undergoing the hard practical tests of every day use, and Engineers of repute in all parts of the United States are specifying "Pioneer" Asphalt materials today, because these materials have proven superior to all others.

Wherever there is a reservoir to be waterproofed specifications should be adopted which will prohibit the use of an inferior grade of asphalt. Wherever pipe line construction is in progress the question of *protection and preservation* of the pipe ought not to be decided upon mere claims, but the rigid demands of *specifications that are safe* should be enforced as a check upon lax methods and inferior materials.

"Pioneer" Reservoir Waterproofing Asphalt "Pioneer" Mineral Rubber Pipe Coating

Here are two commodities that will meet the demands of the specifications suggested. They are not experimental, but have both been used with the highest success for years, and under the severest conditions.

Over 99½% Pure

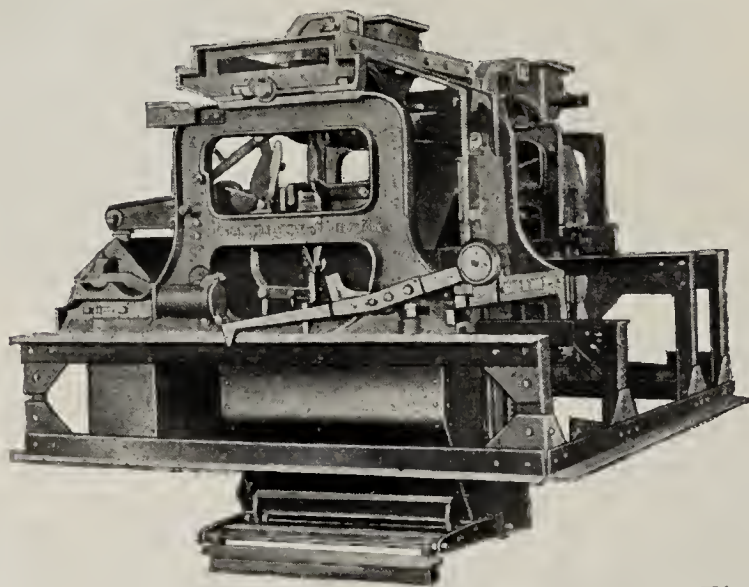
The superior quality of our asphalt is a *proved-out* proposition—a *known quantity*. Our own mines in Utah contain immense deposits of the purest hydro carbon known, our Gilsonite analyzing over 99½ per cent pure bitumen. In any true technical comparison of values "Pioneer" Mineral Rubber Pipe Coating and "Pioneer" Reservoir

Waterproofing Asphalt will readily demonstrate the superiority which has made them practically non-competitive. **Specifications** Send for our specifications and be safeguarded against those asphalt (which are offered as being equal to "Pioneer") the employment of which has, in spite of claims, proven them to be inefficient.

The American Asphaltum & Rubber Co.
600-614 Harvester Bldg.,
Chicago, Ill.

A
14
Year
Record
of Success

TO MAKE THE BEST CEMENT, USE Richardson's Automatic Proportioning Scales



Two or more scales yoked together with our Electric Discharge Mechanism will weigh Crushed Raw Materials direct from bins with perfect accuracy and discharge simultaneously.

These machines fitted with our Conveyor Feed will also weigh Pulverized Materials direct from bins.

Greatest Possible Range of Weights. Exact Proportions Absolutely Guaranteed. Continuous Uninterrupted Operation.

Similar Machines for Clinker and Gypsum. Automatic Hopper Scales for weighing Cement to Stock Bins. Automatic Bagging Scales for Finished Cement. Speedy and most accurate yet devised.

Write for particulars to

RICHARDSON SCALE COMPANY
16 Park Row, NEW YORK 122 Monroe St., CHICAGO

Highest Class Cement Rope Sacks

CEMENT SACKS FURNISHED PLAIN OR PRINTED

Samples and quotations
furnished upon request

CONTINENTAL PAPER BAG CO.

Paper Mill, Bag Factory and Printing Plant

RUMFORD, MAINE

Address inquiries to General Office,

**Whitehall Bldg., 17 Battery Place
NEW YORK CITY**

CEMENT

... AND ...

ENGINEERING NEWS



Cement Stucco Residence of C. R. Erwin, Oak Park, Ill.

Lehigh Portland Cement used in its Construction.

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue
Cable Address—"Seaferts" Chicago.Entered at the Post Office at Chicago, as Second-class matter, July 21, 1896
under Act of March 3d, 1879.

Subscription.	\$2.00 Per Year
Foreign Subscription.	\$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON	Advertising Manager
-----------------	---------------------

Chicago, July, 1910.

THE TRUTH ABOUT CONCRETE.

The July issue of the Technical World Magazine contains an article by B. Brooks entitled "The Truth About Concrete" which, owing to the wide circulation of this journal, will be read by thousands of laymen as well as by all men of the profession.

At first sight, this publication with its numerous illustrations of concrete, failing during construction of warehouses, chimneys and bridges, or decaying in the course of time in sewers, aqueducts and marine constructions, appears to be a skillful attack upon concrete construction by an architect or contractor favoring other methods of building. Upon close examination however, we must agree with the writer, that the best way of safeguarding concrete construction is to fully realize the limitations of this modern building material as well as its advantages and to entrust the erection of concrete structures only to parties who are well conversant with the physical and chemical properties of concrete and are known to be cautious engineers.

On the whole, Mr. Brook's article is a repetition of the arguments advanced by Dr. W. Michaelis Jr. in his paper: "How To Prevent Failure In Concrete Construction", read before the Western Society of Engineers several years ago, through which its author gained the reputation of being the most impartial and upright cement expert in the country.

There are rather few engineers belonging to the profession who dare to tell the truth about concrete. Most of them try to hush all information about accidents and about the unfavorable outcome of experiments carried on for the purpose of studying the limits of application of cement. Others venture to discredit discouraging results and consider it a boon to the cement industry if they arrive, by an ostensible repetition of the experiments in question, at different conclusions; however, they omit to state wherein their experiments differ from those of their predecessors. That similar investigators interfere with the free development of the art and are a detriment to the profession is evident. Technical journals, on the other hand, especially if owned or influenced by men of the cement or concrete industries, are seldom impartial enough to publish without hesitation the truth about concrete. They have to please their advertisers, for whose benefit most of their publications are written. Hence, all unpleasant news is either concealed or the attention is diverted and skillfully directed to some other report stating precisely the opposite, no matter whether the information contained in it is obviously wrong. But with the same partiality all branches of engineering had to contend right along, and yet the industries as well as scientific research progressed; and for this very reason the International Society for Testing Materials was organized,

which is going to make an end to the indiscriminate propagation of reports on engineering subjects and as a Supreme Court in engineering matters, will compel every one to submit his arguments, that they may be compared with the conclusions arrived at by others for the sake of ascertaining the differences in the various methods of investigation, and that a final decision may be formulated in time.

The old-time policy of railroad companies consisted in keeping accidents a secret or in excusing them. To-day they do the opposite; they give them the widest publicity, so that every employee may learn a lesson from them. This has done a wonderful amount of good, as the statistics prove. In a like manner, every wise engineer will admit that it would be the best plan to scrupulously ascertain the cause of failures in concrete construction and to point out how they may be avoided in the future, and to impart this knowledge not only to the superintendents, but to every one who was employed on the work, so that all, from the men in charge of the construction down to the last hand, realize the importance of contributing their share towards making a success of the work and eliminating danger.

There is a good deal of truth in Mr. Brook's article. We share his opinion to the effect that concrete construction is still in the experimental stage and that the constructions of the last decade have been done rather on a large scale without waiting in many instances for the outcome of proper tests or studying the conditions to which the concrete structures had to be subjected. Since we know that concrete is destroyed even by feeble acids and by alkaline solutions, why do engineers expose sewers, aqueducts and pipe lines to these corroding agents? By the expenditure of a comparatively small amount of money, the conditions of the soil could be properly examined, which would tell whether the water percolating through it carries alkalies in sufficient quantities to affect the concrete pipes; or the composition of the refuse water should be determined accurately before deciding upon concrete sewers. Water to be carried through aqueducts should be tested repeatedly in order to find out if it carries carbonic acid in solution, which is sure to soften the concrete if present in noticeable amounts. Instead of doing this, millions of dollars are spent on such work with the result that the structures decay in the course of a few years and that the construction in question becomes a disgrace to the cement industry. Is concrete to blame, if it is thus used in the wrong place?

Undoubtedly, either out of sheer ignorance or out of a desire to prevent other building material from going into the construction, concrete has often been used for conduits in cases in which experts would have declared it to be unsuitable. This naturally decreases the application of cement for similar purposes, as every sewer, aqueduct or drain made of concrete in places, where the prevailing conditions should have precluded its use, serves as a means of discouragement and prevents concrete from being used in a dozen similar cases, in which it would have been of excellent service.

There are a number of additional points in concrete construction to which Mr. Brook takes exception, for instance the lack of building regulations prescribing safe designs and the common mistake of not giving concrete sufficient time to harden. But, as we have dwelt upon these subjects at some length in our April editorial, we refrain from discussing them at this time. And last, not least, the author calls attention to the fire-resisting qualities of concrete which, in his opinion, are exaggerated by most engineers. There is certainly some truth to this statement.

Most builders call fireproof every construction that cannot be ignited like wood and forget that a concrete column, beam or floor with the usual one-inch of fire-protection covering the reinforcing metal are mostly affected by fire to such an extent that they have to be replaced or that they collapse. Viewed from this standpoint, our modern so-called fire-proof constructions are fire-resisting only to the extent of not supplying food to the flames; however, they are, as a rule, sufficiently damaged by fire because they cannot withstand sudden heating and in this direction architects should make an effort to improve our modern constructions.

In cases in which a fire advances slowly from one part of a building to another, as in calm weather in buildings which do not contain much combustible material, ordinary fire-protection by means of terra-cotta tile around structural steel or an inch or two of concrete outside of the reinforcement may be sufficient. But, where there is plenty of food for the flames or where the fire is fanned by high winds or has been confined to one part of the building and rushes suddenly to another part of the structure through the falling in of a wall or breaking in of windows, all members of a structure are exposed to sudden intense heat. Sharp-pointed flames, resembling the flame of a blow-pipe, shoot against columns, beams and girders, and crack the terra-cotta tile or concrete surrounding them, melting the structural steel or reinforcement. In our opinion, architects should provide for such conditions, as they are not rare. What we need, in order to make absolutely fire-proof at least the now so-called fire-proof buildings, is a material which will endure sudden heating and gradually convey the heat to the material underneath. Such material would be asbestos made into tiles that could be dove-tailed into concrete. Nails or wire or metal of any description should be avoided in fastening such tiles to the underlying material, as metal conducts the heat quickly to the interior of the member thus causing uneven stresses. Pure asbestos being too soft would not be suitable. On the other hand, transit board cannot withstand high temperatures. Possibly the asbestos board made under the Hatschek patent would answer the purpose. This has been used as asbestos shingle; yet, to our knowledge, it has not been utilized so far as fire-proofing in the way suggested.

Thus there is room for improvement in all branches of architecture, but especially in concrete construction, and a lecture like that by Mr. Brook, therefore, should be received with enthusiasm rather than indignation. Just criticism practised by men of the profession can never hurt the industry, no matter how strong the language may be in which they condemn existing conditions. Their reproach is followed invariably by sound advice pointing out ways of ameliorating objectionable customs. This reconciles the reader and makes him more willing to reform than if the same rebuke would have come from an outsider who is generally taken for a cynic, because he finds fault without telling us how to correct our mistakes.

What is most desired at this stage of development of the cement industry is to educate people not to surpass the limits of application of concrete. The sooner we learn in which cases we have to avoid cement and how we have to handle it in order to obtain uniformly good results, the better it will be for all parties engaged in its manufacture and application, for the safer concrete construction will be the more general will become its use.

FUSED PORTLAND CEMENT.

By C. Unger.

Translated by W. Michaelis, Jr.

(Continued from page 242.)

Zulkowsky who "for theoretical reasons was convinced of the non-existence of a tri-calcium silicate," made at least an attempt to produce it. The mixture which was burnt for 10 hours in a Seger furnace, disintegrated upon cooling. It did not develop heat in contact with water and set slightly within 24 hours; when placed in water, it was converted into a mud. From the amount of water absorbed, he concluded that his product consisted of calcium oxide and di-calcium silicate. The fact that, notwithstanding the presence of uncombined lime, no heat was developed, he explained by "dead-burning" or "over-burning" of the calcium oxide.

A. Mayer made the following interesting experiment in order to support the "tri-calcium silicate theory: As the calcium-aluminum-silicates supposed to be present in Portland cement would yield colorless crystals, he prepared a cement without alumina, in which the alumina was to be replaced by another metal oxide (Fe_2O_3 ; Mn_2O_3 etc.) that would color the fused product. After burning, his preparations showed again colorless crystals, which he declared to be identical with alite. Unfortunately, his communications made so far, do not contain any analyses, especially not of the raw materials used.

Richardson prepared a raw mixture from impalpable materials obtained by levigation. This was moistened and dried and exposed to a temperature of from 1650 to 1700 centigrade for 5 or 6 hours. The product had reduced its volume considerably by shrinking; it was brittle after cooling, but did not disintegrate. Under the microscope it was found to be optically active and could be easily distinguished from the di-calcium silicate prepared in the same way, which latter did likewise not disintegrate and showed bright interference colors in contrast to the "tri-calcium silicate," which he declared to correspond with the "alite," while the di-calcium silicate, in his opinion, was identical with "belite." However, the fact that certain products obtained by synthesis are identical with some of the constituents in Portland cement, as far as their optical behavior is concerned, does not suffice, as silicates of different composition are often found to be isomorphous.

The Question of "Free Lime": Free lime must be called that part of the calcium oxide contained in Portland cement which is not chemically combined with any element. Free lime, therefore, represents only an admixture to the compounds constituting Portland cement and retains its characteristic properties which manifest themselves by the process of expansion called "blowing." The properties of free lime may be modified, of course, if it is present in the form of a "solid solution." Furthermore, it has to be decided at first, whether or not that part of the calcium oxide which is contained in cement in the "dead-burnt" state is to be considered as free lime. The term "dead-burning or over-burning" is applied to certain limestones which do not slake readily with water after having been exposed to an excessive heat. The slaking process with its rapid development of heat is replaced in this case by a slow process of hydration resembling that of hydraulic lime; the cause of this is to be found in the foreign elements which

the limestone contains and which consists of SiO_2 ; Al_2O_3 and Fe_2O_3 ; these latter form compounds with the calcium oxide. Whether or not perfectly pure calcium oxide can be overburnt or deadburnt has not been established as yet with certainty.

Remark by the Translator: Since Unger's paper was published, Day and Shepherd demonstrated that even chemically pure calcium oxide could be overburnt so that it did not slake, but hydrated very slowly without noticeable development of heat; however, this overburning took place at a temperature far above the burning temperature of Portland cement. They, furthermore, proved that a chemical compound "tricalcium silicate" was out of the question.

In my opinion, it is absolutely unnecessary to assume the free lime to be present in the "overburnt" state. It suffices, in the case of a burnt limestone containing a small percentage of SiO_2 ; Al_2O_3 ; Fe_2O_3 or in the case of hydraulic lime, natural or Roman cement or Portland cement, to imagine every grain of uncombined calcium oxide to be coated with a thin film of calcium silicate, calcium aluminate or calcium ferrite, in order to understand that the water has no immediate access to the particles of uncombined calcium oxide; that the film of calcium silicate and so forth surrounding the grains of free lime must be hydrated at first and that, as this decomposition of the silicates, aluminates and ferrites proceeds slowly, the grains of free lime are hydrated gradually. Thus, owing to the development of heat, accompanying the formation of calcium hydrate, which takes place in the case of a pure limestone all at once, the temperature of pure burnt lime rises to the boiling point of water immediately upon adding water, whereas this same process of hydration of the free lime takes place more gradually in the case of hydraulic lime and occupies about 24 hours in the case of natural cement and Portland cement (which latter, moreover, contain comparatively small amounts of free lime), so that the development of heat is extended over a longer period; consequently the temperature is observed to rise less during the slaking of hydraulic lime and only about 5 or 10 centigrade in the case of mixing Portland cement with water.

The question, whether or not free lime is present in cement in large amounts, dates back to the earliest days of scientific investigation of cements. In the foregoing it was necessary several times to refer to some of the theories assuming free lime and to the objections raised against them. In this chapter the most prominent of these theories shall be discussed and the methods shall be described by which the various investigators aimed to prove the existence of free lime. In connection with this, the work of those chemists shall be mentioned who endeavor to determine the calcium hydrate in the hardened cement.

Of all theories based upon the existence of free lime none has had so many followers as that by Zulkowsky, though his first publication was not received favorably. His views naturally changed in the course of time influenced by modern investigations.

Zulkowsky started out from the high-limed blast furnace slags which disintegrated upon cooling, but which, if poured in water and cooled quickly, formed a coarse sand possessing hydraulic properties in distinction from the slowly cooled product. These two products showed a different behavior towards acetic acid and, for this reason, Zulkowsky termed one "ortho-silicate" and the other "meta-silicate." He found that the hardening of the hydraulic modification was greatly assisted by a small admixture of calcium hydrate, which, how-

ever, did not combine with it. This was proven by the fact that any other solution of alkalies gave the same result without the least decrease of the concentration of the solution. Therefore, he attributed the hardening to a process of swelling aided by the presence of alkalies.

The behavior of certain slags, which was found to resemble closely that of Portland cement, and the observation that a cement was still able to harden, even after part of its lime had been extracted with hydrochloric acid, made Zulkowsky draw the conclusion, "that Portland cement was likewise a high-limed silica-alumina slag of the same constitution as the granulated blast furnace slag."

The increased percentage of lime he declared to be due to the presence of free lime in the overburnt state, which contributed to the swelling. His experiments to prove the existence of free lime failed, so that he ultimately doubted the possibility to ever attain this object.

In order to substantiate his theory he tried to produce some "hydraulites" in the pure state: "Hydraulite" he called all substances able to combine with water and to harden. In these efforts he encountered the greatest difficulties owing to limited devices for obtaining the desired temperatures; moreover, his crucibles were not sufficiently fire-resisting and were easily attacked by alkalies.

The examination of the calcined products involved the determination of the hardening properties and of the water of combination. For the latter he used small amounts of finely powdered substances which were calcined after previous drying in a vacuum over concentrated sulphuric acid.

In the same way as other chemists he found two modifications of the compound $2\text{CaO},\text{SiO}_2$, of which one had hydraulic properties and the other not. This difference he attributed to a different constitution of the two compounds. The inert modification was called "ortho-silicate" and the active "meta-silicate."

In the course of his experiments he had, after numerous failures, to resort to fluxes. He used 3.47% boracic acid. After having ascertained that the corresponding borate, $\text{B}_2\text{O}_3, 4\text{CaO}$, combined with $2\text{H}_2\text{O}$, he calculated the water of hydration of his product to be 7.43%. The experiment showed 6.97% after 3 days, which was quite satisfactory. Other fluxes, however, for instance barium compounds or calcium fluoride, were of no avail.

Among other hydraulites studied by Zulkowsky, those are of the greatest interest to us which are supposed to be present in cement. For the aluminates $\text{CaO},\text{Al}_2\text{O}_3$ and $2\text{CaO},\text{Al}_2\text{O}_3$, which he found to be strong hydraulites, he determined the water of combination to amount to $2\text{H}_2\text{O}$ and $4\text{H}_2\text{O}$ respectively, thus proving that they were completely decomposed into alumina hydrate and calcium hydroxide.

The hypothetical compound $3\text{CaO},\text{Al}_2\text{O}_3$ he did not consider at all, because the temperature required for its possible formation would have been far above the burning temperature of Portland cement.

Of the ferrites, the compound $2\text{CaO},\text{Fe}_2\text{O}_3$ deserved the greatest interest, in his opinion; it combined with 4 molecules of water and decomposed in the same way as the corresponding aluminate.

To this theory, as well as to all other theories assuming free lime, the objection has been made that it did not harmonize with the microscopic observations of Le Chatelier, Toernebohm and others. Of course, it would have been advisable for Zulkowsky to refer to the latter's researches and to explain the point; but his neglect in this matter is certainly not a reason for declaring the results he obtain void; and, although

Richardson remarks that free lime would not remain undetected by the microscope, Toernebohm himself states that the presence of free lime can not be proven by the microscope, because it is isotrope. Also the frequently repeated experiment of Le Chatelier, demonstrating that 1% of freshly calcined lime added to cement causes blowing, is by no means a sufficient cause to belittle Zulkowsky's results, for the free lime contained in calcined clinker is more finely subdivided and possibly also in a different physical state.

However, the method of determining the character and composition of the hardened products by means of water absorption has rightly been criticized. He certainly used only small amounts of his products and allowed the water to react upon them until the weight was found to be constant. Nevertheless, attention must be called to the experiments of others which proved water and aqueous solutions to be unreliable reagents for the examination of the constitution of cements. Furthermore, it had been proven by Michaelis (in 1876) a long time before Zulkowsky made these experiments that only a small part of a cement was acted upon by water, that a cement, after having hardened for 4 years, could be pulverized a second time and obtained a considerable strength. This was due to the decomposition of the coarse cement grains imbedded in it which became active through the second grinding.

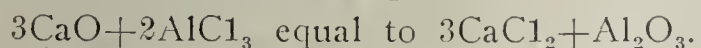
As mentioned before, Zulkowsky gave up all hope of ever succeeding in determining the amount of free lime in cement. In spite of this a great number of efforts were made to this effect, the most prominent of which were the following:

Hart allowed a 10% solution of iodine in alcohol to act upon 1 gram cement. This dissolved:

30% CaO 0.45% R_2O_3 and 1.8% SiO_2 .

The residue was completely soluble in hydrochloric acid. From this he concluded that the cement contained 30% of free lime.

Wormser and Spanjer used carefully dried aluminum chloride in concentrated alcohol in varying concentrations. The chemical progress taking place was supposed to be the following:



The decomposition increased with growing concentrations of the solution. In spite of this, they drew about the same conclusions as Hart.

Both methods, however, were declared by Michaelis to be unsuitable. He proved that the iodine in alcohol as well as the alcoholic solution of aluminum chloride were able to decompose even marble, not to speak of the unavoidable formation of acetic acid and other compounds formed from alcohol in the presence of iodine.

Richter used phenolphthaleine in pure chloroform or concentrated alcohol in order to determine the free lime. Sound Portland cement did not show the least alkaline reaction, not even after having been in contact with the solution for several months, while the smallest percentage of calcium hydrate turned the solution red after a short time; the same occurred in the case of all blowing cements.

As, in his opinion, the uncombined calcium oxide might possibly be contained in cement in the crystallized state, he prepared, by calcining of completely dehydrated $Ca(NO_3)_2$ crystallized calcium oxide. This product did not slake, but disintegrated under water to a coarse-grained powder within 24 hours, which set like cement and which did not blow. However, phenolphthaleine in alcohol or chloroform was turned red also by this crystallized calcium oxide. From these ex-

periments Richter concluded that all calcium oxide must be contained in a combined state in cement.

Rohland was of the same opinion as Zulkowsky who doubted that the question, whether the cement contained free lime, could be settled by purely chemical methods. The reagents so far employed were unfit, as they acted only by means of their hydroxyl ions. The existence of free lime, therefore, could be proven only in the presence of water, no matter how small the amount, which latter was able, at the same time, to decompose the silicates of the cements. He assumed a great amount of free lime to be present on account of the results he obtained from experiments with positive and negative catalyzers. For these tests demonstrated that the velocity of hydration of Portland cement was accelerated or retarded by various catalyzers in the same way as that of calcium oxide.

Rebuffat applied a 10% sugar solution to various cements. Preliminary experiments taught that magnesia was not dissolved by it and that likewise iron oxide and alumina were insoluble in it.

With this sugar solution he treated a number of cements and hydraulic limes in the calcined state as well as after hardening had taken place and divided the calcined products into two groups: On the one hand, hydraulic limes and quick-setting cements, which almost immediately gave off almost all available lime, and, on the other hand, slow-setting cements that gave off calcium oxide very gradually and in steadily increasing proportions until about a month after the beginning of the experiments. From these results he believed to be able to form an opinion as to the amount of free lime present and declared the slowsetting cements to contain all lime in a combined state. Rebuffat then compared the amount of lime set free with the chemical analysis and with the percentage of coarse grains which did not take a part in the hardening and demonstrated that in all cements the products formed during the hardening process are the same, namely calcium hydrate, hydrated calcium aluminate and hydrated calcium silicate corresponding with the composition of the di-calcium silicate, $2CaO, SiO_2$.

Rebuffat's method was rejected by Rohland, Feret and Michaelis. The latter referred to experiments of his own in which sugar solutions were used and which gave proof of the following facts:

1. That different amounts of lime were extracted from the various cements employed, if different concentrations of sugar solutions (8% and 20%) were used.
2. That the percentage of lime extracted varied with the amount of solution acting upon the cement.
3. That calcium aluminate was soluble in sugar solution in large amounts.
4. That from a cement, once decomposed by a sugar solution, after decantation of this solution and washing out, again a considerable amount of lime could be carried into solution by renewed treatment with sugar solution of the same strength.

He positively denied the insolubility of alumina in a solution of sugar in water.

These foregoing experiments amply show that the investigation of the hydrated cements leads to still greater uncertainties than that of the calcined products. The study of the hardened products, therefore, requires unusual precautions.

II. EXPERIMENTS WITH FUSED CEMENTS.

Reason for Fusing Cement: The main object I had in view, in making my experiments, was to fuse all preparations completely, no matter what was their composition. This, of course, was in contrast to the

widespread opinion that a fused cement did not possess hydraulic properties, a prejudice of the practical cement burner who knew from experience that at too high a temperature and by too long exposure to the heat "dead-burnt" or "over-burnt" cement was obtained, that is to say a product which did not set or which hardened only imperfectly. The reason for this over-burning, however, must not be sought in the high temperature employed, but in the faulty composition of the raw materials, as we shall see in the following. That the latter was the origin of it was made probable by the experiments conducted by Michaelis in 1892 and 1893.

This scientist fused cement raw mixtures of various composition by means of an oxy-hydrogen flame and obtained products that hardened exceptionally well and proved to be absolutely sound in spite of a percentage of lime far above the ordinary. From this he concluded that an increase in calcium oxide was not detrimental as long as the burning temperature was high enough. The opposite, therefore, is likewise true, namely that a cement must contain a high percentage of calcium oxide, if it is expected to possess a maximum amount of active elements, as the latter are certainly high in calcium oxide, no matter whether we regard them as tri-calcium silicate or as double-compounds. Hence, cement can be improved by higher burning temperatures than customary nowadays, a deduction amply justified by my experiments.

F. Meyer likewise made tests with Portland cement raw mixtures, that he fused in an electric furnace and obtained sound products. Unfortunately, however, all his preparations were spoiled to some extent by adulterations of calcium carbide originating from the carbon electrodes.

By the experiments formerly mentioned has been demonstrated that the characteristic properties of Portland cement are not lost by any means by the fusing process. The same will be shown on a still larger scale by my experiments to be described later. If it can be proven at the same time that, by fusion, the same compounds are formed as are contained in ordinary Portland cement, a method is given which promises to be more successful in explaining the constitution of Portland cement than all experimental burnings at which the temperature is raised only to the point of vitrification.

The term "sintering" or "vitrification," as customary in practice and used in defining the commercial article "Portland cement," is not at all an expression conveying any definite meaning. It indicates the beginning of fusion, the point at which the mass becomes soft and shrinks. In any event, sintering is accompanied by, or rather is due to, a chemical reaction, as can clearly be seen from the action of chemicals upon cement before and after the burning, and as has been demonstrated by the test of the earliest investigators.

The progress of this chemical reaction during the burning process is difficult to observe. In the manufacture of Portland cement the points of chief importance are, besides the chemical composition of the raw materials: Duration and intensity of the fire, uniformity of the raw mixture, oxidizing or reducing influence of the flame and adulteration by the fuel. These factors have been studied at various times, for instance, by F. Meyer; however, the results attained can hardly be generalized, because it is almost impossible to determine the influence of each single factor in a given case.

In the case of synthetic experiments with vitrified materials the difficulties are the same, though not all factors mentioned have to be considered simultane-

ously. This has often been the cause of contradictory results obtained in the investigations of cements.

Furthermore, it must be assumed that the reactions taking place during the burning process are confined to the particles in the fused state, as reactions between substances on a solid state are infeasible. Consequently we know that, by fusing the whole mass, all component parts must necessarily be converted into a state in which they are capable of acting one upon another, whereby most of the above mentioned difficulties are overcome and a product is obtained, the properties of which depend solely upon its chemical composition.

Method of Fusing Employed: After having decided to raise the temperature, in every instance, to the point of complete fusion, a method had to be devised to make this possible. As very high-limed products were among the mixtures to be fused, which required the highest obtainable temperatures, the electric furnace was thought of from the beginning. However, there were numerous difficulties in the way. Zulkowsky's experiments failed, because he could not find receptacles and supports that resisted alkalies and high temperatures. Fire-clay and platinum were out of the question, as both materials did not withstand the temperature of the electric arc-light. Supports of graphite had soon to be abandoned on account of the unavoidable formation of calcium carbide, and even the carbon electrodes appeared to have an injurious influence.

As the best way to avoid all these difficulties suggested itself the application of the radiating heat of the arc-light alone without letting the substance come in contact with the carbon electrodes. The heat obtained by radiation was found quite sufficient to fuse even pure calcium oxide. The material itself was used as receptacle or support and the molten part of the mixture was, in the case of the small experimental furnace, simply taken out with tongs and, still at white heat, separated from the merely vitrified part, whereby in every instance a sufficient amount of fused material was obtained in order to make all necessary tests. The separation of the fused part from the vitrified or unburnt was always complete, as the determination of free lime proved.

In addition to a small electric furnace with one pair of carbon electrodes, a large furnace was built 12 ft. high with a burning chamber 15 inches wide containing three pairs of carbon electrodes of a diameter of 12 inches. The burning chamber was an inclined plane underneath the electrodes, so that the material could travel downward close to the electrodes. The air, which entered at the bottom of the furnace, passed through the burning chamber and left it heated to a sufficient temperature to drive off, within a short time, all carbonic acid from the raw mixture fed in at the upper end.

Within one-half or one hour the furnace was heated to so high a temperature that even the material of the highest contents of lime was completely fused after having passed the third pair of electrodes and left the furnace in a thick stream which cooled quickly and was removed continuously.

This furnace gave excellent results and enabled me to burn about 200 lbs. in a comparatively short time, which permitted me to obtain a better insight into the behavior of the materials than laboratory experiments on a small scale, that made it always doubtful, whether or not the results obtained were applicable also to the manufacturing process. The small experimental furnace, therefore, was used for all preliminary experiments and for synthetic preparations from pure chem-

icals. As the inside dimensions of the little furnace were limited, it required but little time to raise the heat to the necessary temperature; 100 grams of a perfectly pure fused substance could thus be easily obtained in a few minutes.

In the course of these experiments conducted in the above described manner, both on a small and large scale, no difficulty was encountered in keeping the materials free from calcium carbide, because the mixtures to be fused never came in contact with the electrodes. The small particles of carbon breaking off the electrodes during the burning were removed by the natural draft of the furnace.

In addition to the reasons formerly mentioned for my adoption of the principle of complete fusion, a further advantage had to be expected from this method of working. By Le Chatelier, Toernebohm and others had been demonstrated that sintered Portland cement consisted of crystallized aggregates. The formation of these crystals was attributed to a certain mobility of the molecules at the point of vitrification or beginning fusion and to the combination of the component parts and subsequent precipitation. This explained at once why the crystals were so minute. The small dimensions of the crystals (at best 0.1. mm. according to Toernebohm) made their separation impossible, of course.

By keeping the whole mass in fusion and dissolving all components, that is to say enabling them to react one upon another, crystals would precipitate from this solution only upon cooling; moreover they must become the larger, the more slowly the cooling process would progress.

These reflections led at first to the production of calcium silicates which were prepared in the small furnace with a view of finding out whether this expectation would come true that larger crystals were formed which would lend themselves more readily to chemical and physical examination. This method of advancing gradually from simple compounds to more complicated mixtures was the customary way followed by all former investigators of cement materials.

The possibility existed, of course, that crystals would be formed which could not be separated from the fused mass. But, even then it was hoped that it could be determined whether, in the case of these calcium silicates, characteristic compounds prevailed or isomorphous mixtures. In the former case a sudden change of the properties would have to be expected to take place upon gradual changing of the composition.

Pure Calcium Silicates: For all synthetic experiments the following raw materials were used:

Calcium carbonate leaving, upon calcination, a residue of 55.27% of its weight. This calcined lime consisted of 99.78% CaO and a trace of MgO.

The **Silica** had the following composition:

SiO ₂	76.69%
Al ₂ O ₃	0.86%
Fe ₂ O ₃	0.33%
H ₂ O	21.65%

The **Alumina** analyzed as follows:

Al ₂ O ₃	50.49%
CaO	0.45%
SO ₃	0.85%
H ₂ O	47.80%

It may be mentioned briefly at this place, that the hope of obtaining larger crystals was not fulfilled during these first experiments. If crystals formed, they were so minute that separation for the sake of special

examination could not be thought of. The total analysis of the products was no criterion, of course, whether well-defined compounds were formed; however, their properties seemed to justify the opinion that really three well-defined calcium silicates existed, namely: CaO, SiO₂; 2CaO, SiO₂; 3CaO, SiO₂.

The presence of free lime was determined, in accordance with Richter's method, by phenolphthaleine in concentrated alcohol distilled over metallic sodium. This reaction was tested by the following experiments.

The samples together with the reagent were placed in a carefully cleaned and dried glass which was subsequently closed air-tight. A preparation obtained by fusing of CaO and SiO₂ in the proportions 3CaO to SiO₂ which was supposed not to contain free lime, did not show the least discoloration even after weeks.

Freshly calcined pure calcium oxide, however, turned the solution red after several hours, although it had not been kept in the air, but in the dessicator, for a short time. The same discoloration was observed in the case of a preparation which showed small amounts of free lime noticeable by slight symptoms of blowing. The qualitative determination of free lime consequently seemed to be possible by this method, because the reaction took place also if the water was kept out as far as possible and decomposition of the silicates was excluded.

Mono-calcium silicate: CaO, SiO₂: The surface was smooth and glossy. A broken piece showed crystalline structure. In powdered form it was perfectly white and dissolved in dilute hydrochloric acid without leaving a residue. Mixed with water, it hardened very slowly. The test piece was submerged in water after 2 weeks and showed a gradual increase in strength; however, gave only a tensile strength as low as 68 lbs. per square inch after 8 weeks. Calcium hydrate went continually into solution in the water. The hardening was most likely due to the carbonic acid of the air which was not excluded.

Di-calcium silicate: 2CaO, SiO₂: Taken from the furnace in the state of white heat, it proved to be very hard and crystalline. Upon cooling, however, it crumbled, in every instance, into a fine white powder which microscopical examination revealed to consist of quite irregularly broken minute crystals. Treated in the same way as the mono-calcium silicate, it obtained after 8 weeks (6 weeks in water), a tensile strength of 140 lbs. per sq. in., whereby the carbonic acid of the atmosphere was likewise not excluded.

Now several intermediary mixtures were prepared, for instance mixtures of equal parts of mono- and di-calcium silicate. Hereby even a small percentage of 2CaO, SiO₂ became very noticeable. A product containing 52% CaO (instead of 48.11% corresponding with mono-calcium silicate) did not completely disintegrate, to be true, but broke up into a number of pieces.

While the mono-calcium silicate was easily fusible and the di-calcium silicate did not require much effort, the mixture corresponding with the hypothetical **Tri-calcium silicate**, 3CaO, SiO₂, necessitated prolonged exposure to the arc-light, and even then only a thin layer on the surface could really be fused, whereas the material farther down was only vitrified. All parts merely sintered crumbled into dust upon cooling and only a thin scale of fused material remained which was used for the experiments.

The composition was:

	Determined:	Calculated:
SiO ₂	26.29%	26.44%
CaO	73.61%	73.55%

Only a trace of Fe_2O_3 and Al_2O_3 could be discovered; according to the analysis of the raw materials only 0.23% of them could be present.

The molecular proportions CaO to SiO_2 were 3.018 to 1. The product, therefore, came closer the theoretical composition of the tri-calcium silicate than that resulting from any former experiment on record.

Microscopic examination revealed that this product was composed perfectly uniformly of minute crystalline aggregates. However, it was impossible to make any definite statements about the crystal form; they certainly did not have the slightest resemblance with the crystals with sharp outlines which Le Chatelier, Toernebohm and others designated as the most important constituent of Portland cement.

In contact with phenolphthaleine in concentrated alcohol a very faint discoloration could be observed after many months, while the disintegrated part, which had a ratio of CaO to SiO_2 equal to 2.98 to 1, did not turn the solution red at all. Silicate mixtures containing less calcium oxide than the tri-calcium silicate likewise showed no free lime to judge from the reaction with phenolphthaleine.

The not disintegrated part of the tri-calcium silicate set within 24 hours after having been mixed with water, but disintegrated soon after immersion in water. The disintegrated part, however, kept well in water and obtained fair strength.

Another raw mixture was very accurately proportioned and had, according to analysis, the correct amounts of CaO and SiO_2 corresponding with the formula of tri-calcium silicate. It resulted again in two parts: Fused surface and disintegrated portion underneath. However, the composition of these two products revealed even a greater difference than at the first time:

The fused portion contained....75.3% CaO

and the disintegrated part contained...71.5% CaO .. corresponding with the molecular proportions of CaO to SiO_2 equal to 3.32 to 1 and 2.72 to 1. This time both products showed a very faint red color of the phenolphthaleine solution in alcohol.

Upon mixing with water, the fused portion disintegrated completely, while the disintegrated part hardened well.

These experiments with pure calcium silicates mainly confirm former results. As far as the size of the crystals is concerned, the experiments must be considered as failures. The reason for this seems to be, that all these products have an extraordinarily high melting point; thus it is impossible to keep them in fusion for a long time and to cool them gradually. All devices otherwise employed in order to obtain large crystals utterly failed in this case. Imbedding in molten blast furnace slag or in sand and similar devices are useless, because the samples solidify almost at the same moment when the current is interrupted.

Therefore, other methods were tried, which were simply based upon the reflection that larger amounts of the fused mixtures naturally remained in fusion for a longer time and cooled off more slowly. For this purpose the large furnace proved to be of service. The experiments made on a large scale will be described in the next chapter.

Here the reasons shall still be given why during these synthetic experiments in the small furnace the preparation of calcium aluminates was omitted.

Most investigators take for granted that in cements, in addition to calcium silicates, also calcium aluminates are formed and act independently from the former, without offering any proof for this presumption. Only Rebuffat discusses this question. However, he proves

only, that the calcium aluminate assumed by him reacts independently from the silicates during the hardening process, because a varying percentage of alumina is without influence upon the "slow-setting" calcium silicate which formed. But this does not touch the question, whether the alumina is contained in cement as calcium aluminate beside calcium silicate or whether a double-salt or a complex salt exists. Rebuffat considers this question as irrelevant; nevertheless it seems to be of great interest and of great importance in deciding the constitution of Portland cement and can not remain without influence upon a theory explaining the hardening process.

A number of facts exist which do not support the theory that Portland cement contains free calcium aluminate. These facts, however, have not been taken notice of as they deserve. In the first place, at all silicates occurring in nature the observation can be made that the alumina is inclined to take part in the formation of crystals, mostly by forming double salts. Theories have also been advanced which assumed a direct isomorphous admixture of alumina in many natural silicates.

The assumption of free calcium aluminate in Portland cement is in direct opposition to the observation by Le Chatelier that all "minerals" contained in Portland cement contain both calcium oxide and silica. Furthermore, Richter makes the statement that all calcium aluminates turn phenolphthaleine in concentrated alcohol red, while sound Portland cement does not discolor the solution even after several months.

Hence, the production of calcium aluminates is of interest only, if the hardening process of the cement is to be investigated in detail. I admit that, as far as the products are concerned which form during the hardening, it may be immaterial in what form the alumina was contained in the calcined state.

(To be continued.)

ACTION OF SEA WATER ON PORTLAND CEMENT.

By J. M. O'Hara, Southern Pacific Railway.

The decomposing action of sea water on Portland cement mortar is a phenomenon which is confronting many engineers of to-day and requiring serious investigation. While it is true that some concrete masonry has remained intact in sea water for long periods of time, other structures have been rapidly destroyed when subjected to the same conditions. Many theories regarding the actions of sea water upon cement have been advanced, and considerable knowledge on the subject is available, but the general consensus of opinion seems to be that there is no Portland cement which is known to be capable of resisting absolutely the decomposing influences of sea water. It is not the object of this paper to give any extended account of construction in sea water in which cement or concrete disintegrated, but to give the results of investigations made by the writer on a number of brands of Portland cement subjected to the action of sea water.

In a series of tests made by the writer to select a cement for use in sea water construction, certain suggestive facts were developed which seem to possess considerable interest. During the investigation

three classes of failure were met with: Swelling and bursting of the test pieces in the early stages of hardening; gradual loss of strength in the test pieces by sea water permeating and rotting the cement; softening of the test pieces and gradual falling away.

In studying the cause of desintegration it is necessary to analyze the destroying agent, sea water, and the object destroyed, Portland cement, in the mortar and concrete.

A chemical analysis of sea water shows a content of the following salts: Magnesium sulphate, magnesium chloride, sodium chloride and calcium sulphate.

The essential components of Portland cement are calcium silicate and calcium aluminate. Other ingredients always occurring in appreciable quantities are ferric oxide, magnesia, sulphur trioxide, alkalies, carbon-dioxide and water.

As the object of this investigation was to find a suitable cement for immediate use, an accelerated sea water test had to be determined upon, and was made as follows:

Circular pats were made from several brands of Portland cement, permitted to set in moist air for 24 hours, and then immersed in a fivestrength solution of sea water. These pats were 4 in. in diameter, $\frac{1}{2}$ in. thick at the center, and tapering to a thin edge on the circumference.

The chemical analysis of the solution was as follows: Sodium chloride 11.5 per cent; magnesium chloride 1.4 per cent; magnesium sulphate 0.9 per cent; calcium sulphate 0.6 per cent; water 85.6 per cent.

Within 90 days a number of the pats had disintegrated, or gave indications of failure. The value of this accelerated test is proved by the fact that the cements failing gave indications of failure in ordinary sea water within a year.

Strong solutions were then made with the individual salts contained in sea water, and pats immersed as before; the following results were obtained from the test made:

TABLE I. TESTS OF NEAT BRIQUETTES IN FRESH AND SALT WATER.

Age Water.	7 Days.		28 Days.		2 Mo.		3 Mo.		6 Mo.		9 Mo.		12 Mo.	
	Sea.	Fresh.	Sea.	Fresh.	Sea.	Fresh.	Sea.	Fresh.	Sea.	Fresh.	Sea.	Fresh.	Sea.	Fresh.
"A".....	839	655	969	698	1047	703	961	622	843	579	939	624	813	663
"B".....	772	505	955	637	1062	750	1089	822	644	805	281	789	137	711
"C".....	481	504	664	619	706	628	756	635	666	642	389	707	153	760
"D".....	657	581	749	666	778	636	638	612	117	672	107	684	0	706
"E".....	686	486	867	575	925	564	880	655	737	619	711	573	335	612
"F".....	655	557	811	663	959	725	841	659	800	667	826	747	791	782

TABLE 2. TESTS OF ONE-TO-THREE SAND BRIQUETTES. FRESH AND SALT WATER.

Age Water.	7 Days.		28 Days.		2 Mo.		3 Mo.		6 Mo.		9 Mo.		12 Mo.	
	Sea.	Fresh.	Sea.	Fresh.	Sea.	Fresh.	Sea.	Fresh.	Sea.	Fresh.	Sea.	Fresh.	Sea.	Fresh.
"A".....	256	282	368	338	340	362	340	365	347	421	349	435	352	451
"B".....	205	190	265	308	299	347	280	400	272	468	285	392	300	405
"C".....	142	169	219	243	240	295	264	311	273	372	293	397	279	428
"D".....	231	247	335	369	343	373	285	415	305	443	254	398	288	372
"E".....	222	191	333	299	402	390	379	420	363	417	384	397	379	414
"F".....	229	267	238	361	254	388	258	414	297	446	340	481	355	519

The magnesium sulphate present in sea water attacks the free lime in the cement with great energy; that is to say, the sulphur has a greater affinity for the calcium, so that, when the sea water and the cement come in contact in the nascent state of chemical combination, the sulphur separates from the magnesium and unites with the free lime of the cement, forming calcium sulphate and leaving the magnesium hydrate free. This formation of calcium sulphate with water would imply increase of volume and destruction of the cohesion, but the calcium aluminate in the cement, as discovered by Messrs. Chandlot, Michaelis and Deval, has the property of combining with the calcium sulphate, formed as above, so as to give a double salt, calcium sulpho-aluminate, combined with a large quantity of water with great increase of volume, swelling of the concrete and total destruction of all cohesion.

Magnesium hydrate, formed by the chemical action mentioned above, has a tendency to fill the pores of concrete, and in this way the concrete may become more impervious to the destructive effect of the sea water, and disintegration may be retarded or checked.

Investigation of a number of failures of important works placed in sea water developed the fact that the concrete was high in magnesia, and for a number of years the injurious action of sea water upon hydraulic

compounds was attributed chiefly to the magnesia present in the cement.

As stated above, the presence of the magnesia in the concrete was due to a deposition of the magnesian salts in the water and the magnesia was in no way responsible for the failures.

Magnesia present in cement in considerable quantities in time will cause it to expand and crack, but with the normal amount permitted in Portland cement, it is probably inert and simply present as an adulterant.

If a cement does not contain free lime, when anhydrous, it is no guarantee that it will resist the injurious action of the sea water, however, as the setting of cement under the action of water frees a part of the lime which was combined. It was found that over twice as much lime was extracted, or set free, while setting under the action of sea water as under the same conditions in fresh water.

Undoubtedly sulpho-aluminate of lime, formed as above, is a very active agent in the decomposition of high alumina cements by the action of sea water, and accounts for the swelling and bursting of the test pieces; the first class of failures met with.

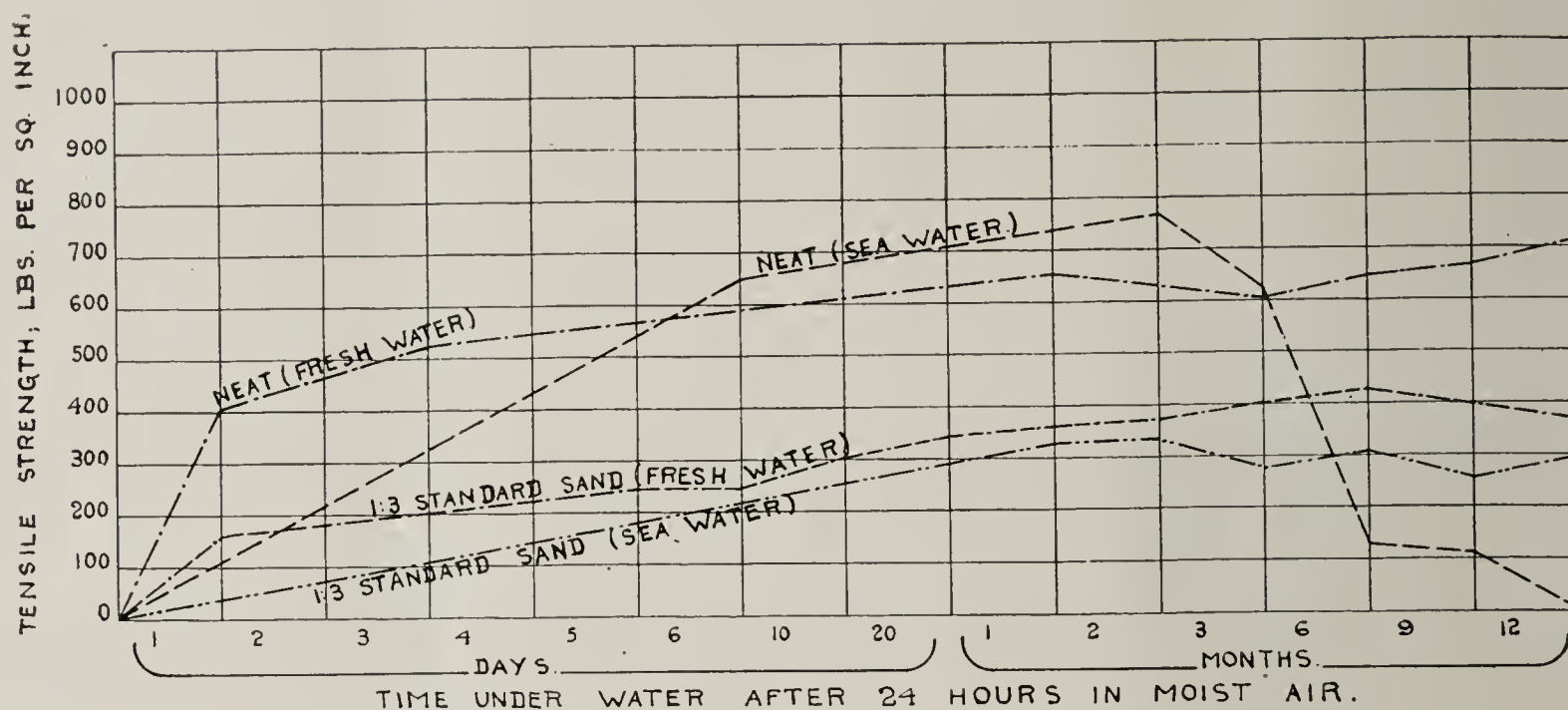
The second class of failures, gradual loss of strength in the test pieces, seems to be the most common.

It was found that sodium chloride, the principal salt in sea water, is able to dissolve the calcium silicate of

the cement, the main factor of final hardening and strength. This enables the sea water to gradually penetrate the mortars and rot the concrete with a total destruction of all cohesion.

The third class of failure, softening of the concrete, only takes place where there is an abnormal amount of sulphuric acid present; this is the result of the reaction of the sulphuric acid of the salt dissolved by the water upon a part of the lime of the cement.

This question of the action of sea water on Portland cement mortar has been the subject of much discussion and investigation among European cement authorities, and, without going into details as to the chemical action involved, it may be stated as the generally accepted conclusion of these authorities that the magnesium sulphate present in sea water acts upon the calcium hydrate of the cement, forming calcium sulphate, and further, that this calcium sulphate combines with the alumina of the cement, forming calcium sulpho-aluminate, which last compound gives rise to swelling and cracking of the concrete.



Sea water has no apparent action on the ferric oxide of the cement.

The setting qualities and early strength of cement are due to the iron and alumina combined with calcium, but as alumina is a harmful ingredient in sea water construction, it would seem that a cement in which the alumina had been replaced by iron is desirable.

It is generally understood, and seems to be widely accepted as a fact, that a dense concrete is impervious to the action of sea water. This settled the sea water question in the minds of many engineers, but the results of tests made by the writer would indicate that the theory is not true, unless the cement used has the inherent qualities to resist the disintegrating action of sea water.

Briquettes were made for physical tests with the same brands of cement used in the accelerated tests, and after 24 hours in moist air, one set was submerged in ordinary sea water.

The briquettes were broken at periods of 7 and 28 days, 1, 2, 3, 6, 9 and 12 months.

In most instances the neat briquettes submerged in sea water acquired abnormal strength very rapidly, while, on the other hand, the sand briquettes gained strength more rapidly in fresh water.

The accompanying tables show tensile strength of six brands of well-known Portland cements in fresh and sea water for stated periods.

It is a well-known fact that the core of a neat bri-

quette submerged in fresh water will be dry after the cement has reached the stage of final hardening. This is also true of neat cement in sea water where the cement has the inherent qualities to resist the injurious effects. If the cement will ultimately fail by the action of sea water, the entire briquette becomes permeated with the water and loses strength by gradual rotting.

This is graphically shown by the curves in the accompanying diagram. This was plotted from the results of the sample marked D in tables.

An average of three briquettes broken after three months in sea water shows tensile strength of 638 lb. per square inch, but the core was not saturated. At six months the strength has dropped to 117 lb. and at this stage complete saturation has set in. At the end of a year the briquettes broke in the clips of the testing machine, while the briquettes submerged in fresh water had a strength of 706 lb. per square inch.

In ordinary routine testing the sand briquettes furnish the best data for construction purposes, but when

the cement is to be used in sea water the neat briquettes give quick information as to what the ultimate results will be.

TRANSFORMING A FRAME STRUCTURE INTO ONE OF CEMENT.

The Application of "Cleveland" Metal Lath and Cement Plaster—Efficiency of this Form of Building—Low Cost and Maintenance.

The owners of dilapidated dwellings of frame construction will be interested to learn that the exterior of their homes can be easily and effectively transformed into a cement plaster house by the application of a coat of cement mortar.

The process is simple and inexpensive, as good results can be assured by the employment of any skilled plasterer or cement worker; it is, however, suggested to retain the services of a good architect to look after the best design for the general appearance. Not only frame houses, but brick buildings which are time-worn can also be overcoated with cement plaster and receive an entirely new appearance.

Such treatment will give a house the advantages of a new stucco or cement plaster construction. While the exterior appearance is beautiful and up-to-date, the old interior arrangement need not be destroyed or

changed in the least. All over the country the most fashionable residences are constructed in cement plaster or stucco. This is due to extreme efficiency of the material, from both first cost and maintenance economy; also by the great latitude offered for originality in design and perfect construction.

The best results are secured by plastering the exterior on "Cleveland" metal lath, manufactured by the Garry Iron & Steel Company, Niles, Ohio, coated with a good quality of pure carbon paint or galvanized coating, as this brand of metal lath offers a better anchorage. The metal lath should always be furred from the studding or sheathing, as, for instance,



Frame Building Before Cement Plaster Was Applied.



After Cement Plaster Was Applied.

with crimped steel bands or strips of wood. This will allow a better keying of the plaster, and in case of a wooden frame house, the plaster will be kept away from the wood, so that the moisture in the plaster will not be absorbed by the dry lumber, for such contact often produces unequal setting of the cement, and sometimes results in cracking the plaster directly over such points of contact. Besides, the dead air space between the plaster and sheathing is excellent insulation against heat and cold.

When overcoating over old siding it is necessary to bring out the door and window trim to even surface with the plaster as shown in the first illustration.

If the trimmings on doors and windows are in too bad condition and it is desirable to remove them entirely, then the following construction will prove very satisfactory: The plaster for this work should consist of Portland cement and sand or prepared plasters compounded especially for exterior work. Ordinary lime should not be used; it weakens the mixture and

materially delays the set. Hydrated lime may be used in the first coat to the extent of 10 per cent.; this will greatly assist the workmen. When using prepared plasters, the instruction of the manufacturer must be followed closely. Finishes are "Float," "Rough Cast" and "Pebble Dash." The float finish is two-coat work, and is, therefore, the cheapest. It is best adapted for surfaces having small area. Rough cast and pebble dash are applied in the third coat, and can be had in great variety of texture and color.

The cost of overcoating houses depends largely on the location of the work, the amount of scaffolding required and the handling of the door and window trim. However, it should not exceed an average of \$1.50 per square yard of the surface plastered, complete, and in small towns and the farm, where all the labor involved in putting on the lath and preparing things ready for the plasterer is done largely by the owner, the cost per yard should be considerably less. Cement plaster requires no painting; this alone guarantees the investment as a permanent improvement. Houses of cement plaster construction on frame structures are not to be considered as fireproof. For rejuvenating old houses, this method of overcoating has proven to be the most thorough, economical and efficient.

TILE TALKS.

The Cement Tile Machinery Co., Waterloo, Ia., has prepared a new book, entitled "Tile Talks." The company states that it "does not attempt to solve with technical detail the many and varied problems in drainage engineering, but rather to point out some of the fundamental principles involved in the more simple problems in such a way as will enable the tiler to solve them for himself." The book contains chapters on tile drainage, effects of drainage, durability of concrete, cement tile, frost resistance, porosity, uniformity, strength, drainage problems, planning a drainage system, elevations, spouty soil, catch-basins, transferring grade to bottom of ditch, depth of a drain, protecting drain outlets, size of tile, helpful hints and suggestions, and road drainage. Send for a copy.

GIANT BLAST OF POWDER KILLS.

Four hundred kegs of powder exploded the other day in the quarry of the Union Portland Cement company near the Devil's Slide in Weber canyon, near Ogden, Utah.

Seventeen laborers are missing and it is believed all were killed.

Those missing are Hugh McGuire, the foreman, seven Italians, seven Hungarians and two Japanese.

Legs, arms and heads of the missing men were found on the hillside across the canyon a hundred yards from the quarry. The body of a Hungarian was hurled out of the tunnel with such force that it cut a telegraph pole in two.

A tunnel had been driven into the hill above the cement plant and the 400 kegs of powder had been placed therein. The workmen were preparing to seal the chamber preliminary to firing the blast when the powder exploded prematurely.

A curious feature of the explosion was that no damage was done to the company buildings in the immediate vicinity, but ranch houses far distant were damaged.

Telephone and telegraph wires were torn down and the first news of the accident was sent to Morgan by courier.

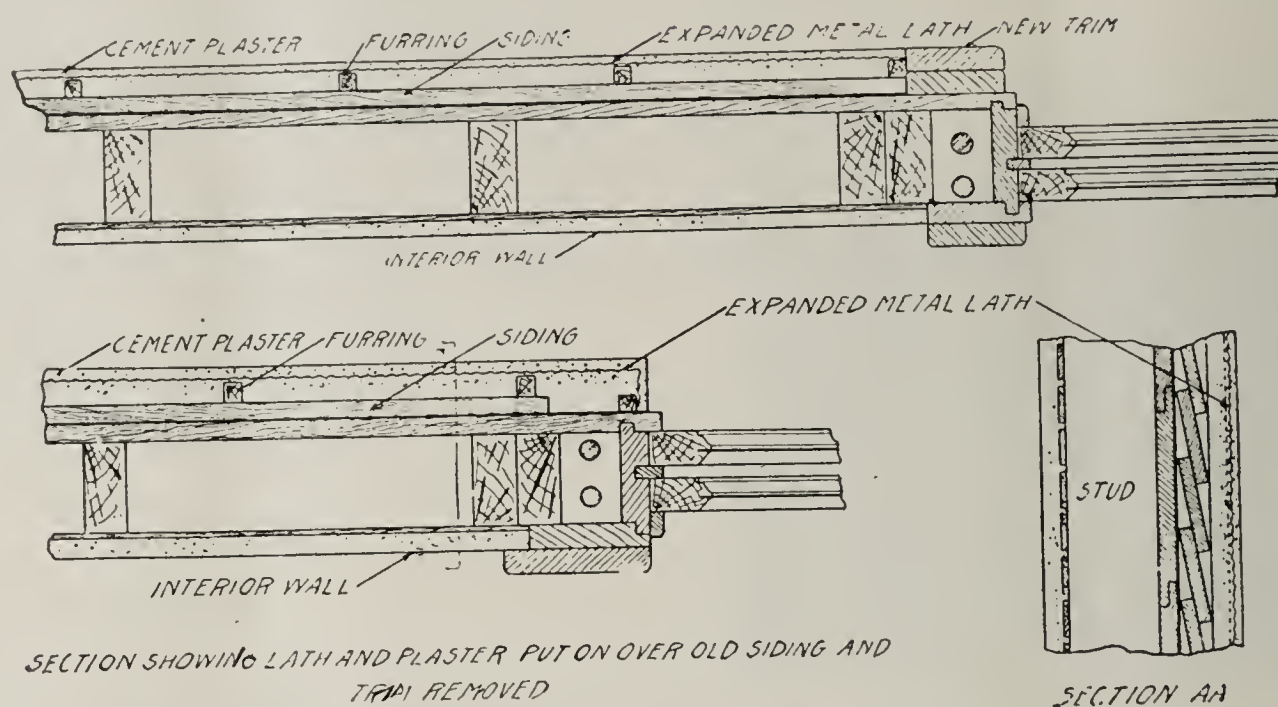
INEXPENSIVE HOMES OF REINFORCED CONCRETE.

By Milton D. Morrill.

What architectural style are we developing today? The Greeks developed the lintel type of architecture, following the natural shapes and sizes of available stone. The Romans built mostly in brick and developed the arch as a natural form for their material. What new type and style will be developed through

been designing in styles suited for wood or brick, and constructing in concrete with shapes unsuited and unnatural to the material in hand. This has, of course, made work difficult and expensive. On one design for a seven room house with a large living room a contract figure has been given as \$5,500. A frame structure could hardly be built for less.

The science of living has been given little study, and many of us consider carefully in our work how we can economize in labor. But in our homes there is a great



Transforming a Frame Structure Into One of Cement.—Page 290.

the use of reinforced concrete? There must be a concrete style. We have already worked out the structural forms which seem best suited to the material, and possibly the best concrete buildings have been designed by engineers, as they have followed the simplest and most logical shapes, and have not been hampered by architectural precedent.

We architects are so wedded to traditional forms, such as cornices, columns and arches, that we are likely to employ these in positions where they serve a decorative rather than constructive function. Is there any reason why structures cannot be designed in the simplest and most natural forms for concrete, and still be beautiful in proportion, line and color? Cannot honest construction be made decorative and beautiful without requiring a masque of false architectural detail or an imitation in materials?

It has seemed to me that in cement work we have

waste of effort and energy through unstudied plans. Upon studying the problems of housing, I found that a box house was by far the most economic form which could be constructed enclosing a given space, as this form requires the least wall area. The box is also the most rigid and substantial, as is illustrated by those of pasteboard in daily use. While of a fragile and flimsy material, these become firm and substantial when reinforced at the corners. The idea of a box shaped house is not attractive to us, but why cannot this form be made beautiful? We see carved and decorated jewelry cabinets, which are exquisite, why can we not design attractive homes within similar lines, being guided more by the law of common sense, fitness and beauty than by precedent, in following an architectural style, which at best cannot be suited in structural forms so changed.

In all our large cities contractors are building rows

upon rows of houses, and in the majority of cases plans are not furnished by leading architects but they are bought from the man who will make them at the cheapest price. Contractors will employ the best doctor they can find for their families, but in these buildings operations, the best architects are cut out because they cannot compete with unstudied and inferior work, and the public must see and live in these buildings which are not beautiful, and sometimes even offend the eye. I believe that all our cities should have art commissions which would pass upon designs for fitness of appearance, just as our health departments demand sanitary plans.

There are certain limitations to the economic use of concrete and we might as well recognize these and design our work accordingly. When we come to intricate detail and curved surfaces, concrete work becomes difficult, on account of the necessary moulds. Simple straight lines are ideal for this work, and after all they make the simplest and most attractive buildings.

I have adopted in all plans standard unit dimensions, so that drawings are reduced to mould diagrams after we have the design, and if we follow our diagrams the building is bound to come out right. One of the plans is so arranged that it can be built in sections almost as a bookcase is put up, being complete in four, five, six and seven room houses and arranged so that any number of rooms to twelve can be made or added with no alteration. For a group of those houses the fireplaces, stairways, ice-boxes, sinks, etc., are of standard type and in steel moulds are made at a quarter the cost of our less substantial wood fixtures.

As before mentioned, a competition for sanitary inexpensive workman's homes was held at the late International Congress on Prevention of Tuberculosis, when this house was awarded the first gold medal. The following are a few of the special and for the most part new features which have been incorporated in the design:

The roof is of open cellular construction, cool in summer. An attractive feature of the house is the roof garden and sunroom forming out-of-door bedrooms, divided by use of movable screens.

We cast our walls for two story buildings 6 inches in thickness, and you can realize how far a cubic yard goes in this thickness. With the steel moulds we can place this for \$5.00 per yard, so that a wall 9 feet by 12 feet the side of a room, will cost but \$10.

When the model house was first shown there were many skeptics as to the practicability of this scheme, and I thought that the best plan was to construct a house along these lines as an ocular demonstration is the only way to give definite proof.

A house of this character is in Brentwood, Maryland, near Washington. It has very little wood except the windows, sash and doors, the walls are 8 inches in thickness the floors are 4½ inch slabs reinforced. The moulds were of wood made in standard sections. One carload of Portland cement sufficed for construction. To thoroughly clean a room a hose is used, the cement floors being graded to plugged tile spouts, discharging on the lawn. An enclosure for the garbage pail is left under the wash tub which has an outside screen door for ventilation and removal. This is arranged to be flushed out. A small wood strip is laid in the border so that rugs or carpet can be tacked in place, if desired. All corners are coved, and all fixtures are bracketed from the wall, which leaves no places for the shelter of the dust, vermin or insects, and facilitates cleaning. The possible omission of insurance and repairs and their general indestructible character makes

this type of building especially suitable for rented houses. The waste from the kitchen range heats the house through circulation of hot water, being so built that in summer an inside fire-box cuts off the house heating system. All fixtures such as kitchen range, sinks and wash tubs are cast in concrete, and given a very smooth cement finish. For the water supply a concrete tank is built in the top of the bath room which is filled from a small force pump at the kitchen sink.

It is difficult to base an estimate of cost on construction of the first house, since the moulds and the superintendent's time has been charged against it, but it is safe to estimate that these houses can be built in groups at between two hundred and three hundred dollars per room. In the construction of concrete houses, I have found that in some light work the cost of lumber and carpentry labor for moulds was three-fourths the total cost. It is necessary that this estimate should be reduced or eliminated, as we are to build in this material.

I searched the market in this connection, for standard sectional steel mould equipment and found several good types but none suiting my requirements. The simple equipment used is the result of many months experimental work, and should, I believe, do much to reduce the cost of concrete construction, since it practically eliminates carpentry and lumber waste. The mould plates are pressed from No. 12 gauge sheet steel into flanged sections 24 inches square. Upon the completion of the footing course the plates are locked to the cement, spacing blocks furnishing a trough, into which the mix is poured. The cement spacing blocks are of course left in the wall and the plates are locked to these by a key, which is afterwards removed. Wherever four corners join, a cuff engages, wedges the plates together and draws them to perfect alignment on the inside. The whole stands very rigid and firm when erected, and in experimental work, I have not found it difficult to keep work plumb, as the corners give alignment. The plates are two tiers in height, each tier being clamped together in series, and attached by a hinged rod so that the lower tier is unlocked and swung to its new position on top and locked, there being few loose parts to fall. The whole equipment for house construction has only ten parts and as it costs about \$800.00 and can be used indefinitely, the cost per house is not great. Several small sections of walls have been built with this equipment, and within two weeks I expect to start on the first work for which a full equipment is now being finished.

The plates are locked together in the same way for the floors. The spacing blocks here give the exact thickness of slab and reinforcement rods are placed and accurately secured to these blocks by bedding a heavy wire which is cast in each block and protruding for this purpose. To give a smooth and even floor surface a wet mix is poured in, and the plates are slid in place on top and locked to spacing blocks, and wedged down until the surplus mix is squeezed out in front; this should do away largely with expensive labor in cement finishing. For the floors cement spacing blocks are cast with projecting flanges so that they will give considerable support to the slab and reinforcement and permit the lower plates to be removed after three days. A post being wedged and blocked up under each spacer giving supports only 24 inches apart.

I have found upon experiment that a slight ridge or pattern was formed by the joining of the mould plates and spacing blocks were found to show of slightly different color. I have treated this as wall decoration,

and with the rosettes cast on the spacing blocks, an extremely interesting pattern is formed, and it is possible to leave the wall without further finish inside or out, unless a brush coating is applied to give a more uniform color, and as a safe guard against dampness. As the plates are cleaned and greased each time they are raised and as the concrete is very wet mix, no plaster is required.

CONCRETE BUNGALOWS.

The small concrete bungalow is becoming more and more popular among home builders who desire a

low. The danger of fire is reduced to the minimum, with consequent saving in insurance; practically no painting or repairing is required except on small portions of exposed woodwork; and in the case of the houses described below the heating cost was reduced to about \$25 a year.

The concrete bungalows shown here were designed and constructed by Mr. W. H. Parrish, at Rosslyn Farms, Carnegie, Pa., a suburb six miles from Pittsburgh. Mr. Parrish who is a practical builder, and has built several residences of wood, stone and brick, says that he can keep the cost of a concrete cottage under that of stone and brick, and about six per cent above



Concrete Bungalow of Leland G. Cummings, Rosslyn Farms, Carnegie, Pa.

house substantially built with modern conveniences at a moderate cost. For suburban or country residences the bungalow type is especially desirable, and when constructed of concrete offers so many advantages that the increasing popularity of such houses is readily explained.

The first cost of such buildings can be kept very

that of a frame dwelling. The bungalows illustrated have five large rooms and a bath on the first floor, and two rooms on the second floor, and are built of monolithic reinforced concrete and with all modern conveniences at costs which were all less than \$4000.

The method of construction is somewhat unique. The studding, (2 in. x 4 in.), is erected in the same



Concrete Bungalow of Richard G. Harris, Rosslyn Farms, Carnegie, Pa.

manner as for a frame house, except that the studs are spaced on 16 inch centers. For the inside form, $1\frac{1}{2}$ inch by 14 inch plank are set up between the studding, flush with the inside edge. One inch spacing strips are then nailed on the top, middle and bottom of the studding to hold the plank in position. Thus, upon the removal of the plank after the concrete has hardened, a $1\frac{1}{2}$ inch air space is left between the concrete and the plaster.

The outside forms are built against 2 by 6 inch timbers spaced opposite every alternate stud in the wall. This form is $3\frac{1}{2}$ inches outside of the studding and is held at this distance by spacing blocks $3\frac{1}{2}$ inches long. With these in place the uprights of the outside form are wired to the stringers and thus held in place while the concrete is being deposited. This spacing gives a concrete wall 6 inches thick, and a total thickness of wall including plaster on the inside and out of about $8\frac{1}{2}$ inches.

niture and hangings could be removed from the rooms and a hose turned upon the interior, without doing any damage.

The average individual has an unfavorable impression of exposed cement surfaces for the interior of homes, and is little acquainted with the practically unlimited artistic possibilities offered by cement for interior use.

For mantels there is no material that can equal concrete. Any design, no matter how complicated, can be executed, although the molded effects are much better for showing the nature of the substance. Colored cement floor tiles and mosaics may be used for ornamentation, and the effects thus obtained are distinctly pleasing.

Cement, properly treated, makes a warm and delightful interior, with an atmosphere of charm and beautiful simplicity entirely its own, and obtainable with no other building material.



Concrete Bungalow of J. F. Baker, Rosslyn Farms, Carnegie, Pa.

Over the basement windows a 2-inch angle iron is placed, wire being above and below the first floor windows and a half inch wire cable completely surrounding the house and fastened to the studding is embedded in the concrete.

In building this house a rather wet mixture of concrete is used in the proportions of one of cement, two of sand and six of machine slag, all varying in size from $\frac{1}{2}$ inch to $1\frac{1}{4}$ inches. The outside of the wall is not spaded so that the cement plaster used on the exterior will have a good bond. The cement plaster is mixed in the proportions of one of cement to two of sand, with an addition of slaked lime sufficient to render a plastic and readily trowelled mortar.

Why more people do not erect buildings of this type is hard to say. The construction is ideal, the cost moderate, and the maintenance expense almost nothing, for the insurance is low and the paint and repair bills trivial. Replacements due to rotted lumber are entirely eliminated and the annoyance and worry caused by the fear of a fire avoided.

At a slightly greater first cost concrete roofs, trim and floors could have been added to these bungalows, and then there would be no repair or paint bills whatever. Another advantage of this latter construction would show at house-cleaning times. The rugs, fur-

REINFORCED CONCRETE MILLS.

The conditions of the cotton mill operatives, and how better to provide for their welfare, was the general topic treated in the several papers read at the session of the National Association of Cotton Manufacturers' semi-annual meeting at Bretton Woods, N. H. The Session was opened with the reading of various papers among which was a treatise on the subject of "Housing Mill Employes" by George H. Miller, of Boston. G. V. S. Michaelis, of New York, spoke on Ventilating and Humidifying Mills. Lawrence Whitcomb of Boston, on Loss of Power in Transmission. J. P. H. Perry of New York on Reinforced Concrete For Mill Construction.

Mr. Perry in his address asked: "Why is it that reinforced concrete has been used so little for textile mill buildings when for other types of industrial structure its adoption has been at an increasing rate? To a concrete man this condition is hard to understand.

"On the face of things," he said, "reinforced concrete would seem to be an almost ideal material for mill buildings, and yet with few exceptions there are practically no textile plants built of this very generally successful structural material. A study of the situation brings to light the fact that those who have the

decision as to the class of construction which shall be used in mills seem to misunderstand concrete or at least fail to appreciate certain of its properties.

"When concrete was first being introduced as a building material in this country, one of the chief difficulties confronting its sponsors was the fact that they had to ask the owners with whom they were negotiating to accept their statements as to the worth of the material almost wholly on faith.

"They could not cite as examples factories or warehouses several years old which were built of reinforced concrete and which were in better shape than when first turned over to the owner. It would seem that now with the large number of industrial buildings to refer to the task of converting an owner to this type of construction would be simplified. In purchasing machinery or in buying an automobile the average man is, from Missouri. He is best convinced by a demonstration. In submitting for your consideration various features of reinforced concrete the attempt will be made to refer wholly to experience and presenting facts, not theory, showing that this material is entitled to your approval.

"Vibration is probably as frequently discussed by the textile world as any other phase of industrial procedure. Its effect upon mill buildings has been most carefully studied, and its cure or at least its partial elimination sought. Among mill interests there seems to be a strong feeling that vibration is the one reason why reinforced concrete is not servicable for their buildings; among practically all other industrial executives, vibration is generally considered the chief factor in influencing them to use concrete. The majority of owners of concrete plants are well satisfied that they get less vibration with this kind of construction than with any other type of building. Is the vibration of a textile mill so much worse than that in other factories that a structural material, which has been so uniformly successful as has concrete, is not to be trusted?

"The Robert Gair Company, manufacturers of paper goods, have a large plant in Brooklyn, N. Y., consisting of two six-story brick and first-class mill construction buildings and one nine-story and basement reinforced concrete factory. All three structures are filled with the heaviest presses, cutters, embossers, etc.—every type of the latest papermaking machinery. The vibration in the mill construction buildings is such that a plumb-bob hung parallel to any one of the walls will sway to a considerable extent; in fact, the buildings show that it would be difficult to produce more severe vibration than they are subject to. The reinforced concrete structure directly across the street, subject to the same conditions of foundations, loads, vibration, etc., is remarkable for its rigidity. This building measures 231 by 200 feet 6 inches and is nine stories and basement, having ten acres of floor space and an interior of a typical floor space.

"These presses operate rapidly and have very heavy reciprocating parts, yet a coin can be stood on edge anywhere on their base frames and it will remain in position as long as left there, which is a fair test of the vibration—this being on the seventh floor of the building. All through this great factory one may lay his hand against a column and feel scarcely a tremor. The saving in such a building in repairs to machinery and in power necessary to operate same will be discussed later.

"Reinforced concrete was chosen because it best met the requirements of all kinds of manufacturing companies. If changes were so very hard to make in con-

crete buildings would J. B. King & Company have erected 14 new concrete buildings in seven years, or would the Murphy Varnish Company have awarded 10 contracts to one concrete construction company for new buildings work in two years, or would Robert Gair Company have doubled the size of its concrete factory after having used the first half for two years, testing it, under every conceivable condition as regards alteration to machinery and shafting layouts? This matter of making changes in concrete building has been greatly exaggerated.

"The repairs to machinery, the renewals of bearings, the amount of power required to operate machinery the maintenance of shafting and all similar changes in a manufacturing building of reinforced concrete are lower than in the mill construction type of factory. Shafting or machines once attached to or set up on concrete floors remain in place. There is no tendency to walk and to getting out of line with consequent increased wear on moving parts and bearings together with an increase in amount of power necessary to operate. The superintendents of several of the large companies occupying reinforced concrete buildings about New York City have stated repeatedly that they consider this one property of concrete buildings more valuable than any other. In the Robert Gair building, previously mentioned, there is a saving estimated by the owner to be \$5000 a year on this item alone as compared to the mill construction building used by the company under the same conditions.

"If concrete floors are objected to as being either hard on the operatives or producing dust which would seriously interfere with the manufacturing process, it is quite possible to install wooden floors on top of the concrete slab. This of course increases the cost, but not seriously so. As a matter of fact the prejudice against concrete floors to work on is largely dying out among employes in the average plant. It is true that for perhaps ten days a mill hand will find that his feet hurt him if he is working on concrete, but after ten days at the outside he gets used to it and learns to wear thicker soled shoes and his complaints are likely to be few, because he realizes that the floors are there to stay, whereas he necessarily is not a permanency. The great advantage of a concrete floor over a wooden one, in that it can be easily washed and is of itself more sanitary, has worked to bring about the use of concrete in nearly all plants.

"Concrete walls do not need waterproofing. Because of the dampness in many concrete block bungalows, the impression is that reinforced concrete buildings having walls of the same material are damp. This is quite the opposite of the facts. After considering the merits of reinforced concrete as a structural material, its wide usage for industrial buildings of all kinds, its good record in the textile mills built of it, its fire resistant qualities and its ultimate economy, it is difficult to understand how the textile world can fail to adopt this method of mill construction in place of its present slow burning type."

THE NEW BUILDING ESTIMATOR.

"The Building Estimator" by William Arthur, a book containing cost data, well-known among architects and contractors for the past six years, has been revised and enlarged and the prices have been brought up to date. In the present form it comprises 500

pages. It is published by the David Williams Co., 14 Park Place, New York.

A number of new chapters have been added to the subjects dealt with in former editions, so that the new issue is bound to replace within a short time the copies worn out by use and, in addition to this, is sure to find access to the libraries of many builders or persons engaged in building trades who remained unacquainted with this valuable guide-book heretofore.

A brief abstract of some of the hints given to contractors and a few notes taken from the chapters on "Manufacturing Buildings" and "Concrete Construction" will best illustrate the value of this publication:

This is an age of machinery, and the "Building Estimator" is put forth as another labor-saving machine.

The astonishing developments in metal lath, expanded metal and concrete have turned our old figures and ideas upside down. The walls of immense manufacturing buildings are now put up only two or three inches thick. It is time to recognize this new method of construction in a new book.

Perhaps I should say a few words as to how estimating is done and trouble avoided. It might be as well to pass on without doing so, as experience is the best teacher, but some counsel may be ventured:

In the first place, there is no such thing as time in proportion to cost in estimating. On some buildings an estimator might spend three or four days in figuring mill work alone, and on others a few hours might be sufficient; while \$1000 of hardware might take as long as ten times that amount of plain brickwork. Examine a plan before you promise an architect to take it back with your bid in a few hours.

In making up an estimate it is better and safer to keep each factor of a complete bid separate, to finish and double-line it, and to make a summary of all the items at the end. By this method, any error or change in plan—in brickwork, suppose—can be added under its proper heading without affecting plaster or hardware; while if the total is carried from page to page, it is impossible to change a figure without making a risky change necessary clear through.

And the same system should be followed under all subheadings. Suppose, for example, that there are twenty to forty different items of concrete in a foundation: If the whole amount is set down as so many cubic yards, there is no way of making a separation in case of a change. If a change is made, the whole laborious work has to be gone over again; while if set down in detail, probably three-fourth of the figures have only to be copied.

Get the exact cost and add whatever profits you think possible. You will not get anything extra in these latter days. Some contractors add the profit on each article as they go along and can never tell exactly what they have apart from the cost. It is not a good practice.

In making an approximate estimate for an owner or architect, be liberal. There are many different ways of increasing the cost of building by the addition of a few words to the specifications.

Do not be afraid of an extra. It has its advantages. Architects do not, as a rule, like extras, and owners who order them groan when the bill is presented, but why should they? The proper way is to settle for an extra before a tool is lifted, but whether this is done or another method followed, the matter ought to be cleared up at the end of each month.

Any architect who is worth houseroom will give a written order for an extra so that the contractor may have authority to go ahead. If an architect asserts that the work belongs to the original contract, the

time to settle the matter is when both parties are familiar with the conditions.

It is rather a risky thing to sign a contract which gives one party the sole rights to settle all disputes,

If possible use the "Uniform Contract". It may be safely signed without examination. For many years it has been under the eyes of builders, architects and lawyers in all sections of the country, and the general conclusion is that for contractors and owners alike it is the best contract ever devised. Of course, if an owner has the power, he will use another and more one-sided instrument: that is human nature.

If you are so fortunate as to proceed from estimating to construction, insure against fire, lightning, tornadoes and accident to person or building. "Then", you say, "the insurance men would get all the profits". It is a sad state of affairs, but can you risk all you have? Suppose two or three men are killed? Suppose a fire gets the upper hand? I remember a firm that finished a schoolhouse ready to turn over. Their insurance lapsed, and the building was destroyed by fire before it was accepted. That ended their career in the building line.

Do not accept any contract where the reserve is more than fifteen percent, unless you have plenty of money—and if you have, why be a contractor? Do not give a bond for more than one third of the contract, and fight for one fourth, which is enough. If the owner is afraid of a ten percent reserve and a bond for even one-fifth, he ought to hunt up another contractor, for he is clearly dealing with the wrong man.

It is but right that a contractor should be paid for material delivered on the ground. Many states do this, and so does the United States. But a contractor, no matter what his financial standing, should be obliged to show receipts for material embraced under his previous payment before another is given, or else show a waiver from his material men.

Manufacturing Buildings.

We live in an age of machinery; and the house that held the old anvil under that spreading chestnut tree, is far too small for our requirements. A class of buildings has arisen that belongs, like the skyscraper, to the American style of architecture. Like the skyscraper also they belong rather to the engineer than to the architect. The latter is merely called to hang a curtain over the framework to keep the cold and rain out—and the curtain in some of them is of expanded metal and concrete only two in. thick.

These manufacturing buildings are now to be found all over the country for electric light works, locomotive shops, foundries, steel works and rolling mills, tin-plate works, bridge-building and ship-building establishments, pipe foundries and manufacturing plants of all kinds which are equipped with electric travelling cranes that lift anything from 120 lbs. to 120 tons.

The author gives for three mill-buildings, 150 ft. wide and from 300 to 500 ft. long the cost in percentages as follows:

Brick	16.4	10.2	13.3
Cut Stone	1.2	1.1	1.5
Lumber	6.2	10.0	6.4
Millwork and Glass	5.5	6.0	6.0
Carpenter and Labor	4.1	5.3	4.0
Gravel Roof	1.7	1.4	1.7
Skylights and Glass	8.0	9.5	10.6
Tin, Copper, Galv. Iron	1.1	1.1	1.5
Steel Lintels for Doors & Windows	5.2	5.0	7.0
Painting	2.4	2.3	1.9
Steam, Water, Power Piping	3.2	3.1	2.0
Structural Steel	45.0	45.0	44.1

Concrete Construction.

Concrete	Per Yd.
With Portland Cement at \$1.60.....	\$5.75
With Portland Cement and Forms.....	6.50
With Natural Cement	4.95
With Natural Cement and Forms.....	5.70
Forms—50 Cents to.....	1.75

On building No. 7 the average cost of several thousand yards was 95c, but this was for concrete only. The average labor on forms was 28c per yard additional. Of course, small foundations cost more than large ones. Forms are necessary when ground is wet, when piers have a special shape, or rise above the level.

Machine Foundations: But, while 95c was the average on the main buildings, on the machine foundations where special and complicated forms had to be made, the cost of concrete mixing ran from \$1.50 to more than \$3, with an average of several hundred yds. \$2.05. In addition to this, the labor on forms per cubic yard was \$1.42. The quantities are small on such work, the angles are many, bolts are to be set, and the work has to be carefully leveled and smoothed on top. The excavation for the same foundations ran to \$1.00.

Unloading: The unloading of sand and stone from cars to ground only for the work on building No. 7 ran to 12c per cubic yard of concrete in wall. This figure has to be added to mixing, if material is not delivered with teams.

Lumber: The average cost of lumber and nails for forms was 10c per cubic yard of material in wall. Of course, the same forms and lumber can be used several times. If instead of piers there is a continuous foundation, the forms cost only about half as much for labor, and there is less lumber used. With piers, building No. 7 required 7000 ft. and 3 kegs of spikes to each 1000 yards. For continuous basement walls allow studs, shores and planking full height around about one quarter of building and change when work is dry. Put labor at \$10.00 per 1000 yards. Of course, the walls are at once put all around to a certain height, and the planking raised, but allowance may be figured as stated.

Cost of Forms for Concrete: For estimating the cost of forms for retaining walls and piers. "Engineering Contracting" gives the following rule:

Multiply the number of sq. ft. of surface area of the sides and ends of the wall or piers by 2.8 and the product will be the number of board foot required for sheet blank and studs for the forms.

If the form lumber can be used more than once, divide the number of board foot by the number of times that it can be used, to ascertain the amount to be charged to each pier.

The foregoing rule is based on the assumption that the sheeting plank will be 2 in. thick, and that the upright studs will be 4 by 6 in. spaced 2½ ft. center to center, or 3 by 6 in. studs spaced 2 ft. center to center. No allowance is included for timber to brace the studs, since it is customary to hold the forms together either with bolts or with ordinary No. 9 telegraph wire which weighs 0.06 lb. per ft.

Where carpenters wages are \$3.00 a day, forms can be erected and taken down for about \$8.00 per 1000 bft. Since there are 2.8 bft. of forms per sq. ft. of surface area of concrete to be sheeted, it costs \$8.00 times 2.8, or 21½ cents per sq. ft. for the labor of carpenters erecting and taking down the forms. If lumber is worth \$24.00 per 1000 board foot, the lumber itself costs \$24.00 times 28 or 6¾c per sq. ft. of concrete surface; but if the lumber can be used 3 times, we have

⅓ of 6-¾, or 2-¼ cents per sq. ft. of concrete as the cost of the lumber, to which must be added the 2-¼ cents per sq. ft. for the carpenters' labor, making a total of 4-½ cents per sq. ft. of concrete surface.

By dividing the total number of cubic yards of concrete into the total number of sq. ft. to be sheeted with forms, the number of sq. ft. per cubic yard is obtained. Multiply this number of sq. ft. by 4-½ cents, and the product is the cost per cubic yard of material and labor for the forms, assuming the material to be used three times.

To illustrate: Suppose we have a concrete pier averaging 18 ft. high, 6 ft. thick and 12 ft. long, what will the forms cost per cubic yard, assuming that the lumber in the forms can be used over 3 times? The surface area of the two ends of the pier is 6 times 18 or 108 sq. ft. for each end, or 216 sq. ft. for the two ends. The surface area of the two sides is 2 times 12 times 18 or 432 sq. ft. Hence the total area to be sheeted with forms is 216 plus 432 or 648 sq. ft. Now the total number of cubic yards is 6 times 12 times 18 divided by 27 or 48 cubic yards. Hence there are 648 divided by 48 or 13-½ sq. ft. of form per cubic yard of concrete. Since the forms will cost 4-½ times 13-½, or 60-¾ cents, practically 60 cents per cubic yard of concrete have to be paid for the labor and material in the forms.

Each job should be figured in this manner, for it is evident that if a wall is thin, the cost of the forms per cubic yard of wall will be high. If the wall is thick, it will be low.

It is often possible to make the forms in panels, or sections, which are not knocked to pieces each time they are moved, but are moved bodily. Then they may be used again and again, not only effecting a saving in lumber but in labor. But in calculating the number of panels that will be needed, and the number of times that they can be used, it must be remembered that it is not safe to strip the forms from the concrete inside 24 hours, even of retaining walls, and that where the concrete must act as an arch or beam, as in bridges and floors, the forms must usually be left in place at least 2 weeks to give the concrete time to gain enough strength to carry its own weight and any construction loads that may come upon it. On the other hand, centers and forms for small sewers, up to 5 or 6 ft. diameter, are usually moved with safety within 24 to 36 hours, provided the work is not done in freezing weather. In cold weather concrete takes longer to set or harden, and in very cold weather it will not set at all unless protected from the cold.

Heating and Hoisting: If material for concrete has to be heated, allow \$1.00 per cubic yard extra. If it has to be hoisted, allow 50 cents per cubic yard extra for the first story for an ordinary amount, but less for a large job; and 30 cents for each additional story.

Machine Mixing and Forms: All the heavy foundations for building No. 8 were mixed with machines at a cost of 75 cents, forms about 50 cents extra.

While writing this part, a Chicago contractor, who allows \$1.00 to \$1.35 per cubic yard, informed me that on a certain contract for 4,000 yards in Louisiana, 30 men with a concrete mixer put in 105 cubic yards per day. The difference is not so great as one might expect, but with a machine there is a better assurance of good mixing if work is done by contract; and even the best cement is wasted unless the mixing is well done. This was in New Orleans, where the negroes do not work so hard or effectively as whites do elsewhere. On another large contract in Chicago, 20 men with a mixer put in 100 yards a day. In both cases the engine man was included.

Concrete Mixers: Different sizes of concrete mixers

run in price from \$300.00 with nothing but the skids and pulley to \$1,600.00 mounted on a truck with steam-engine and boiler. The reports from more than a score of users give results ranging from 60 to 350 cubic yards in a day according to the size of the machine. The cost is set down by some as half that of hand labor. An allowance of from 5 to 8 yards per day per man is given.

Cost of a Cubic Yard of Concrete:

Crushed stone at \$1.50 per ton (2250 lbs.).....	\$ 1.69
Portland cement, 1.1 barrel at \$1.60.....	1.76
Sand. 0.6 cubic yard at \$1.00 per yard.....	0.60
Labor	1.50
Water	0.15
Total.....	\$ 5.70

The engineering department of the B. & M. R. R. allows for average concrete as follows: 2,300 lbs. of crushed stone; $\frac{1}{2}$ cubic yard of sand; 1 barrel of cement; \$1.00 to mix.

From 2,300 to 2,350 lbs. of stone is a fair allowance. In work of large proportions it was found that 2,260 lbs were sufficient for a yard of concrete; but on small work on the line where there is more chance of waste, 2,500 lbs. are allowed and the excess used for filling. For the foundations of building No. 7, 2,300 lbs. were allowed and 2,200 used, along with 0.6 cubic yard of sand.

Measure or Weight: Stone and sand would be bought by the cubic yard, if contractors had their way, but the dealers prefer to sell by weight on account of freight charges. If they come wet, it does not take so much to make a ton as when dry; and granite weighs more than lava, although a cubic yard of the one does not fill any more space than a cubic yard of the other. Of course, concrete can be made more expensive by increasing the quantity of cement. Two barrels are given to a cubic yard in a rule before me; $1\frac{1}{8}$ to $1\frac{1}{4}$ is a quantity often used. There is a certain point beyond which more cement means waste, and it is the duty of the architect or engineer to discover it and stop. The contractor is apt to make the discovery ahead of either.

But as the business of an estimator or contractor is largely to follow the specifications and ask no questions, it is well to give a rule for quantities based upon different proportions. Take four for an illustration: 1 Cement, 2 Sand, 4 to 5 Stone is considered the best, but an excellent concrete can be made with more stone.

1:2:6 Concrete: 1 Cement, 2 Sand, 6 Stone.

1:2:4 Concrete: 1 Cement, 2 Sand, 4 Stone.

1:2:2 Concrete: 1 Cement, 2 Sand, 2 Stone.

1:4:10 Concrete: 1 Cement, 4 Sand, 10 Stone.

The large mill of an Eastern cement factory is built to the roof on this last proportion though it seems rather weak.

1:2:6 Concrete: There are 27 cubic foot in a cubic yard. On a 1:2:6 basis this means 3 cubic feet of cement, 6 of sand and 18 of crushed stone. But it has been found by experience and experiment that about $\frac{1}{2}$ more material is needed to fill the spaces between the crushed stone, and again 0.35 of material to fill the voids between the grains of sand, so that using 4 for sand voids gives a large enough extra cement allowance. Stone then being 18 gives 9 cub. ft. of space, and the sand being 6, gives 2.4 cub. ft. of space, or altogether 11.4 cub. ft. we are short owing to the voids. Adding 1, 2, 6 we have 9 parts; dividing the 11.4 cub. ft. by 9 we have 1.267 cub. ft. for a unit. To keep the materials in the same proportion add 1.267 to 3, making 4.267 cub. ft. of cement; 2.534 to 6, making

8.534 of sand; and 7.6, or 6 times 1.267, to 18, making 25.6 cub. ft. of crushed stone, a total of 38.4 cub. ft.

Voids: Trautwine gives us the exact proportion between uniform crushed stone and voids as 0.53 stone and 0.47 space, but the half is exact enough for practical purposes. Sand runs about 0.65 solid to 0.35 voids. It is advisable that the voids be filled or more than filled—and this puts a stop to using too much stone, but leaves room for sand. For 1 cubic yard in place, the foregoing figures allow 1.43 of loose material.

1:2:4 Concrete: There are 7 parts in this proportion, and 27 divided by 7 gives 3.857. This makes 3.857, 7.714, 15.428. Taking 0.5 of stone and 0.4 of sand for voids, we are short 10.8 cub. ft. The seventh part is 1.543. This added in the proportion of 1, 2, 4, gives 5.4 cement, 10.8 sand, 21.6 crushed stone, a total of 37.8 cub. ft. Here sand is half of stone, and the voids will not only be filled but the stone will not touch; and this is consequently a better concrete than 1:2:6.

1:2:2 Concrete: Worked out in the same way, this is 7:34 cement and 14.69 for both sand and stone, a total of 36.72. There is less waste through voids in this proportion, and consequently the total is smaller. It is too rich, but is introduced to show that by this method the quantities regulate themselves. Theoretically sand should be half of stone, for with 0.47 voids 0.5 insures enough material to keep stone from touching, but if the quantity of stone is fixed by the proportion chosen, enough sand and cement have to be added to make up the yard.

It is often said that a cubic yard of concrete requires a cubic yard of crushed stone, half a cubic yard of sand and a barrel of cement, but that depends upon the proportion. In the last case nearly two barrels of cement were required and only a little more than half a cubic yard of crushed stone.

Having found the number of cubic foot, it is necessary to multiply stone and sand by weight, if tons are desired, and divide the cubic foot of cement by 4.4 to get loose barrels, or 3.8 to get packed.

1:4:10 Concrete: 27 divided by 15 equal to 1.8; times 4 equal to 7.2; times 10 equal to 18. The voids amount to 11.88 divided by 15 equal to 0.793, which added in the proportion of 1, 4, 10 equals 2.59, 10.37, 25.93, a total of 38.89. So may any proportion be worked out.

FIRES: EFFECTS ON BUILDING MATERIAL AND PERMANENT ELIMINATION.

By Frank B. Gilbreth.

A remarkable paper, Bulletin 418, just issued by the United States Geological Survey, entitled The fire tax and waste of structural materialism in the United States, by Herbert M. Wilson and John L. Cochrane, contains the following astounding data:

"The total cost of fires in the United States in 1907 amounted to almost one-half the cost of new buildings constructed in the country for the year. The total cost of the fires, excluding that of forest fires and marine losses, but including excess cost of fire protection due to bad construction, and excess premiums over insurance paid, amounted to over \$456,485,000, a tax on the people exceeding the total value of gold, silver, copper, and petroleum, produced in the United States in that year.

The actual fire loss due to the destruction of buildings and their contents amounted to \$215,084,709, a

per capita loss for the United States of \$2.51. The per capita losses in the cities of the six leading European countries amounted to but 33 cents, or about one-eighth of the per capita loss sustained in the United States. In addition to this waste of wealth and natural resources, 1449 persons were killed and 5654 were injured in fires."

In discussing this waste, Charles Whiting Baker, editor of *Engineering News*, in an address before the meeting of the national engineering societies on the Conservation of Natural Resources, March 24, 1909, said:

"The buildings consumed, if placed on lots of 65 ft. frontage, would line both sides of a street extending from New York to Chicago. A person journeying along this street of desolation would pass in every thousand feet a ruin from which an injured person was taken. At every three-quarters of a mile in this journey he would encounter the charred remains of a human being who had been burned to death.

The results obtained indicate that the total annual cost of fires in the United States, if buildings were as nearly fire-proof as in Europe, would be \$90,000,000, and therefore that the United States is paying annually a preventable tax of more than \$366,000,000, or nearly enough to build a Panama canal each year.

It will be incidentally noted that fire protection involves the use of 2,000,000 tons of metal, having a value in excess of \$127,000,000, and the metal in 350,000 hydrants, having a value of \$30,000,000, all of which is wasted on account of the need of preparing to fight fires of a kind which, because of the inflammable character of building construction in this country, would develop into conflagrations without adequate water service and fire departments.

The estimated cost of private fire-protection, including capital invested in construction and equipment, aggregates about \$50,000,000, and the annual interest on this sum and the annual cost of watchmen's services amount to about \$18,000,000."

In this age of "conservation" it is amazing that so little has been done to prevent destruction by fire, and to apply the lessons that every great fire teaches us. The interest of the entire public in fireproof construction flares up with a great fire, but flickers out before the building permits for new structures are granted. The average owner when rebuilding even finds fault with the authorities whose duty is to enforce the inadequate existing ordinances relating to non-combustible construction and to "fire-stopping" in combustible buildings.

There must probably be more big fires among buildings now built, but there is no sane excuse for any such loss in the buildings to be built in the future. Within the last six years there have been wonderful opportunities for studying great fires here in our own country. It has been possible to observe the destruction that occurred, to discover why it occurred, and to determine exactly what must be done if repetition of such destruction is to be prevented in the future.

The writer has been fortunate in being able to make careful observation of the great fires at Toronto, Sioux City, Baltimore, San Francisco, Chelsea and elsewhere. Having become interested in the effects of fires as observed in Sioux City and Baltimore, the observations in San Francisco were made with great care and detail. The ruins of each of the 503 city blocks in San Francisco fire were visited and studied. This led to the formulation of definite conclusions which have since been again checked by the Chelsea fire. The conclusions here presented, therefore, are not the result of theorizing or reading only, but of painstaking and directed observation.

All great fires are alike. Building material behaves the same in a fire regardless of the location. We will therefore study a typical building in a typical fire.

The building of the Mutual Life Insurance Company at San Francisco was a steel frame structure, eight stories high, of the best construction in 1892, when it was erected. The laying up and filling of the joints in the brick, stone and terra cotta were as nearly perfect as possible. The exterior wall completely enclosed the steel frame, which was put together with bolted connections. The floors were of hollow terra cotta flat arches, and the partitions were hollow terra cotta blocks. The damage to the building, which necessitated the removal of the upper six stories, was practically all done by fire.

This building is excellent for an illustration, because it shows the good and bad points of many different kinds of incombustible materials, which were used in its construction. We took it down after the fire, photographing every part as it was taken down.

Examinations while taking down a building give the ideal method of studying the cause and effect and possible remedy for damage by fire.

The pictures illustrate better than could any description the process and the stages of removal. They show also that a very small quantity of wood in a so-called "fireproof" building built almost entirely of non-combustible materials will furnish sufficient heat to destroy it. The lessons from this and from all fires point to these conclusions. No structure of the future should be built of wood. No structure of the future **should contain any wood**. It has taken costly lessons to teach us this, but if we have at last learned the lesson, the price we have paid is cheap.

It has long been realized that, with the wood supply of the world constantly diminishing, wood was bound to become too expensive to use as a building material. But it is not so widely realized that the day when wood is as costly as non-combustible building materials is **here**. Today, concrete structures, and in some localities other non-combustible structures, can be erected at no greater first cost than wooden ones; with an added element of safety to those who use the building which cannot easily be overestimated.

Cost of Concrete Construction.

In order to hold the place it claims—that of the cheapest and best fireproof construction material—concrete must be able to show itself cheapest in first cost, as well as cheapest in the long run.

Concrete materials are obtainable everywhere: stone, ledges, gravel, sand, burnt ballast, slag, brick refuse, terra cotta chips, stone cutter's refuse and cinders are all good aggregates for concrete.

As far as the cost of the labor of putting the material in place is concerned, much has been done toward reducing that to a minimum. With metal forms and certified concrete, concrete construction is cheaper today than that with brick, hollow terra cotta tile or any other material.

Charles T. Main, a member of the Society, has recently published the most valuable contribution regarding cost data of brick and wood mill construction. Mr. Main is a leading authority on this subject, and his data are conceded to be correct. Mills have been built entirely of concrete, in all parts of the country in less time than it is possible to build them of brick and wood and for less money than the square foot and cubic foot prices collected by Mr. Main. A few years ago this statement would not have been true. Today, with the aid of new designs, new methods, new forms, scientific grading and proportioning, it is a fact that cannot be disputed, but one, nevertheless, not generally known.

The development of the entire concrete building and of the parts of the concrete building have been slow, because it has taken a long time to learn to **think** in concrete. Each student brought his stock of experiences from another field to bear on the problem, but the problem was so new that few could understand it in all its aspects. The engineer who knew how to design the strength, knew little about artistic features. The architect, who alone could give beauty to the building, was not an expert in the methods that make low costs. Progress was made more difficult by the fact that so few of the structural features and construction methods were standardized.

The contractor having analyzed his cost, saw that the forms were the largest single item in the cost of the concrete. This fact had its effect on the design of the concrete building, in the trend toward straightway repetition form work and flat-slab ceilings, with as little beam and girder work as possible. A further benefit was in the fewer corners for fire to attack or for interruption of the action of sprinklers, saving also in the cost of the sprinkler system.

After the flat-slab ribless type of ceiling, with its low cost of forms, came standardizing of the units of forms for walls and columns. With the use of these metal form-units a new problem faced us, namely, slight modification of design to agree with the cheapest labor requirements of the metal forms. The influence was also felt, of the fire protection design thoroughly worked out and standardized by Charles L. Norton, professor of heat measurements at the Massachusetts Institute of Technology and engineer in charge of the engineering experiment station of the Factory Mutual Fire Insurance Companies. Mr. Norton's recommended practice, which is now universally accepted, is so simple and apparently so obvious that we sometimes forget to give him the credit for his work.

The importance of the forms, from the standpoint of economy, in being able to build fireproof buildings for the price of brick and wooden mill construction, is clearly shown by the fact that Charles D. Watson, of Syracuse, N. Y., on account of the reduction in the number and expense of forms, has been able to build a number of buildings from separately cast members and reduce the costs below anything ever cast in wooden forms.

Use of Metal Forms.

We come now to the latest developments, the metal form-units that have been perfected, densifiers for compacting the concrete, mechanical conveyors for displacing the wheel-barrow and hand tamping, and the concrete-producing factory centrally located. These things have all arrived. Metal molds have reduced the price of concrete to that of wooden construction.

For the greatest saving in the cost per cubic foot of the completed building, the methods of construction, as well as the designs, must be standardized. This is rapidly being done. For example, the metal forms are set up and concrete is hauled in large quantities from a centrally located factory and poured at once for the entire story of a building. This does away with the joints between the work of two different days, and permits of figuring the tensile strength of the concrete in design calculation, with great consequent saving of reinforcement. Such calculations cannot be safely figured unless the whole story is poured at once.

Bearing on Ultimate Cost of Health Considerations.

Figuring the cost of furring, lathing, plastering, interest, fixed charges, heating, and repairs, concrete is certainly cheaper than wood. If you also figure

health, concrete is very much cheaper. A concrete building is cooler in summer and warmer in winter than any other kind. It can be cleaned out with a hose. It can be easily, quickly and thoroughly fumigated, room by room, or all at once. It is drier than any other, provided it is built with self-ventilating air spaces in all of the exterior walls. A concrete building is vermin-proof, and should germs or vermin get in the building, it may be easily rid of them.

The 1907 Year Book of the Department of Agriculture says (Page 98):

No one of our wild mammals, possibly not all combined, does as much damage as the common rat

The rat continues to cause great losses throughout the United States. During the past year an attempt was made to ascertain the approximate damage done to property by this rodent, in the cities of Washington and Baltimore. Many business men were interviewed, including dealers in various kinds of merchandise, feeders of horses, managers of hotels and restaurants, and manufacturers. The inquiries included all sections of the two cities, and both small and large dealers. Data were obtained from some six hundred firms and individuals, from which it was estimated that the annual loss from rats in Washington is about \$400,000; in Baltimore, upwards of \$700,000. Assuming, as is probable, that similar conditions obtain in all our cities of over 100,000 inhabitants, the damage by rats in these centers of population entails a direct loss of \$20,000,000 annually. This enormous sum gives an idea of the still greater total loss inflicted by this rodent throughout the length and breadth of the land.

The rat continues also to excite grave apprehension because of its agency in distributing the dreaded plague and other diseases. Boards of Health and the Marine Hospital Service in several of our maritime cities have been prosecuting active war against the rodents, and large sums have been expended in efforts to effect their extirpation. No one method has proved adequate, and only by concerted, systematic, and persistent efforts is it possible to reduce and keep down their numbers. The rat-proof construction of buildings, the constant use of traps, and the use of poisons wherever possible, will go far toward assuring public safety. Experiments with various poisons and mechanical means of destruction have been made during the year, and a report of the subject with recommendations will soon be issued.

If wooden buildings are to be tolerated because of their alleged low cost, consider then that the concrete structure furnishes no hiding places for the rats and mice that cause damage amounting to a large rate of interest on over a billion dollars annually. There is no danger in exterminating rats by wholesale poisoning in concrete buildings, for there are no cracks for them to crawl into and die.

Advantage of Concrete Construction in Elimination of Fire Loss.

It may seem that we have wandered from our subject of fires and their permanent elimination, but it was necessary to show that concrete is thus, from every standpoint, cheaper than wood, its only rival for low cost. Concrete construction is the best form for the elimination of fires, because it affords:

- a) Least cause for fires.
- b) Least amount of damage to structural parts by fire.
- c) Least amount of damage to structural parts by water.

- d) Least amount of damage to contents of building by water.
- e) Least quantity of combustible structural materials in a room.
- f) Least speed of combustion of the contents of a room.
- g) No concealed fires; all fires are in plain sight.
- h) Least spread of fire to adjoining parts of the same story.
- i) Least spread of fire to stories above.
- j) Least spread of fire to next buildings.

The causes of fires this paper will not discuss. The amount of damage done by a fire in a concrete building depends upon circumstances perfectly within our control and predeterminable. With concrete made of properly selected fire-resisting materials, practically no damage is done, except by prolonged high temperature. The results of recent tests by Prof. Ira H. Woolson, a member of the Society, and his assistant J. S. Macgregor, prove conclusively that a concrete building properly designed, with as few projecting corners as possible, will withstand long periods of the hottest hardwood fires, with no resulting damage that cannot be thoroughly repaired with mortar and a plasterer's trowel. These tests were on full-sized rooms with walls of concrete made of different kinds of material.

Concrete for walls can be poured in metal molds with sufficient accuracy to permit of painting or wall-papering without further plastering or smoothing. This means that the best of this fire-resisting material is brought to the very surface of the wall where the flames strike. With metal molds all corners can be made rounded as cheaply as square, or metal corner beads may, if desired, be inserted and retained in the molds. Now, if a fire does occur in a building made of concrete cast in smooth metal forms, the damage is less than in any other type of building and the danger of spreading is less.

A concrete building can be damaged by water less than any other form of construction. To begin with, water does not injure concrete; in fact it improves its quality. There is no wood to swell, and afterwards to shrink and crack the plastering. Even the paint best suited to be used on concrete lends itself particularly well to washing down with water. There are no hollow spaces that the water can flow through, damaging the contents below. A concrete building is water-tight from floor to ceiling, and small quantities of water can be easily handled through small scuppers, either into the air space of the vaulted wall, or through the wall to the outside. The fire is never hidden by the construction; consequently no unnecessary streams of water are flooded into the building.

In a concrete structure there need be little or no combustible material. Let us take for example the dwelling house, for it is the most difficult to make both cheap and fire-proof. In a concrete residence there is little trim that cannot be made better and cheaper of Portland cement than of wood. The chair rails and picture molding can be made of concrete. The trim around the windows and doors can be molded in metal molds as cheaply as straight members. Even the wire moldings can be done away with, and the conduits buried in the concrete partitions, walls, ceilings and floors. Baseboards should be made of concrete or else omitted entirely—as they serve no useful purpose in a concrete building, except in following wooden precedent. Windows may have cement sashes, with wired glass and self-closing shutters or self-dropping shutters of rolled-

up metal or asbestos. Metal furniture may be used. The paint and varnish used on buildings and furniture should be selected carefully, as these are great factors in determining the temperature at which a fire will start and the speed with which it will spread. There is also a great difference in the paints and the varnish used for painting concrete.

The flooring need not be of wood. There are many first-class non-combustible materials beside Portland cement that will fill every good requirement of wood and still be fire-proof. There are also parquetry floorings, made of slow-burning wood, and much thinner than the old-fashioned hardwood floor, which make the best flooring in case wooden floors are desired. In a concrete residence there is no excuse for wooden under-flooring nor for wooden screeds.

The best form of construction for the elimination of fires is one that keeps the fire in plain sight, once it is started. One of the greatest obstacles in fighting fire in wood construction is the difficulty of locating a fire after it is known to exist. Every second of time lost gives it accelerated fury. Holes cut through the walls, floors and ceilings to locate a fire oftentimes only furnish more drafts to feed the flames.

With hollow concrete blocks, or monolithic cast-in-place walls and partitions there are no chances for the fire to be concealed. There is no cause for cutting into the partitions, floors or ceilings. There is no damage to the structure from cutting, no injury from water. With such a building, if a fire does start, it starts in plain sight, remains in plain sight at all times and can be attacked instantly before it has spread; and the water damage will be practically nothing. Fires in plain sight are usually extinguished before the arrival of the fire department.

Checking the Spread of Fires.

The spread of a fire into adjoining parts of the same story is possible in a concrete building only through doorways, pipe holes, etc. A concrete wall is an ideal barrier to the spread of any fire. Not only is it incombustible, but it is unaffected for a long period by any but extremely high temperatures. Its coefficient of expansion, 0.0000555 to 0.0000060, is practically the same as that of steel; consequently, there is no damage from unequal expansion of the concrete and its steel reinforcement. As for doorways, any of the makes of fireproof doors and windows well made in accordance with the requirements of the Boston Mutual Fire Insurance Company will stop completely almost any fire. There are metal-covered doors made that very few people can distinguish without touching from mahogany or other hard woods. These doors will confine any ordinary fire to one room in a concrete building; or they will hold any fire in one room long enough to enable the fire to be handled after it has got by the door.

The spread of fires in the same story is very slow compared with the spread vertically. Fire may be communicated from one story to another by means of well-ways, stairways, or holes in the floors, or by the fire passing out of a window on one story and in at the window above. In a concrete building, the floor forms an ideal fire stop even if the walls have been furred or lathed with wood.

There are so many good and cheap metal lathings and furrings on the market today that wood should be prohibited everywhere. While metal does cost more, in the long run it is cheaper to use. With vaulted concrete walls there is no real need of furring or lathing. Concrete construction is particularly well adapted

to plastering directly upon the concrete. Furthermore, only one coat is needed to make the same quality of work as two or three coats upon wood or steel lathing. When the plastering is put directly upon the wall, there is no space in which the fire can travel.

The regular openings can be protected in the accepted way, and kept free from combustible contents.

The spread of a fire to the next building is caused by the combustible gases distilled by the heat from the paints, and varnishes, and even from the wood itself. This explosion (which firemen call hot-air explosion) sets the building on fire in several places at once. While the contents of a concrete building may burn, such a fire will not ordinarily make heat enough to cause the fire to jump wide spaces between buildings. As a further guard the best window, whether translucent or transparent, is one of wired glass. The wires should extend out from the glass sufficiently to be embedded in the concrete sash, holding the glass in place, even when it is heated to a point where a sash of other material would drop the glass or where the glass would fold down and lose its former shape.

The disuse of wood in building construction will mean:

- a Saving of forests.
- b Uninterrupted business.
- c Saving of life.
- d Saving of buildings.
- e Saving of the contents of buildings.

Government Aid in Advancing Fireproof Construction.

The work to be done to reduce fire losses to a minimum is so great and so important that it can never be thoroughly and completely done until the Government takes it in hand. The Government could aid fireproof construction in various ways.

- a By passing laws restricting the use of wood in buildings.
- b By levying taxes, discriminating in favor of fireproof houses and against wood in construction.
- c By educating the people by Government documents on how to build fireproof houses.
- d By establishing a Government bureau for disseminating information regarding honest unbiased fire tests on material, together with Government experiments on different full-size buildings—kinds, types, materials, etc.—with bulletins of the progress. The cost of this would be but a trifle compared with the benefits. There are several men specially qualified to advise on this work, as they have been doing such work in their own laboratories for years.
- e By building fireproof houses for the use of Government Departments and disseminating information concerning them by means of bulletins.

In the meantime, prize competitions would cause special investigation and study in all parts of America for the best house. A few attempts at such competitions have been made in the past. The judges have generally awarded the prizes, in accordance with their best ability, to the designer whose plan pleased them most. Instead of this, the award should have been made to the competitor who could show the lowest cost per cubic foot, for the finished house with certain specified fireproof requirements. After the standard requirements of a house have been fulfilled,

and developed in accordance with the best scheme of fire protection, durability, low cost, permanency speed in building, and comforts in winter and in summer, it is then time to add those beautifying effects that are so necessary from an art standpoint. Such a competition would show to the amazement of many that a better house can we build more cheaply of incombustible materials than of wood.

Conclusions.

The only excuse for using wood construction is its low cost. Today—here—now—we have an incombustible material, a material at a less cost than wood that has stood and will stand high temperatures for long periods without injury. Wood must not be used. We do not argue that no other non-combustible material shall be used, and that concrete shall be used exclusively. There are many cases where other non-combustible materials have special merits. They should be used when it is advisable to do so. But now that we have a cheaper and incombustible substitute for wood, wood construction, wood trim and wood finish should be legislated and taxed until wood is eliminated from all building construction.

METHODS AND COST OF CONSTRUCTING CONCRETE SEWERS AT RICHMOND, IND.

By Fred. R. Charles, City Engineer.

In this city for the past three years we have been using concrete to a large extent in sewer work. Our experience includes the use of concrete pipe, non-reinforced and reinforced both with rods and bands, and with expanded metal, and of monolithic sewers, built in trenches of different natures, rock, earth, quick sand, running water, etc., and employing various methods of reinforcement.

* * *

Our reason for adopting concrete so largely is the fact that vitrified pipe, of course, is not made in such large sizes, and the cost of the largest sizes made is almost prohibitive, and that sewer brick is expensive here, and brick layers who can do sewer work are scarce and high-priced. We have excellent material for concrete right at hand, which costs 75c to 80c per cubic yard delivered on the ground, while cement costs \$1.25 to \$1.55 per barrel, so we are enabled to obtain excellent results much cheaper than with brick or vitrified pipe, after we get above 24 in. diameter. Below that size vitrified brick is preferable with us.

* * *

The next season we built several miles, employing both concrete pipe and monolithic construction, in sizes 54, 48, 42, 36, 30, 24 and 20 inches. The 20 in. pipe was not reinforced, and our experience was not satisfactory; however, in my opinion owing largely to carelessness in making and seasoning, which was done in the heat of summer without affording protection from the sun, or sufficient sprinkling. But in that size I would prefer a vitrified pipe to a non-reinforced concrete.

Forty-two-inch was the largest size we used in concrete pipe. This was made according to the "Sheets" system, in which expanded metal is used for reinforcement; thickness of shell is 1—1-12 in. per ft. diameter; 24 in. pipe made in 2½ ft. and larger sizes in 3 ft. lengths. Pipe is made in a mold consisting of

an outer shell casing and an inner collapsible shell. The pipe rests on the end upon a pallet, and each end is formed by a shaping ring, so that it is notched or rabbitted through half the thickness of the shell, on the outside for one half the circumference, and on the inside for the other half of the circumference. The pipes are laid so as to form a grove at the joint, coming on the interior for the lower half and on the exterior of the upper half, whereby the mortar is always plastered downward in cementing the joint. For handling and placing in the trench a tripod or beam derrick is needed with a block and tackle or chain hoist, as the weight is considerable. Our average cost to lay these pipes, including plastering the joints, was for 42 in. \$0.083; 30 in. \$0.06; 24 in. \$0.053 per lin. ft.

Our first monolithic work was on a sewer 48 in. in diameter, all in rock and about 18 ft. deep. Being new in the business, the design was probably stronger than necessary. Thickness of shell is 6 in. reinforced with $\frac{1}{2}$ in. longitudinal and circumferential rods, the latter being in two portions, bent to the required radius and long enough to give a good lap at the spring line. The trench was first shaped to the outside of the sewer, allowing proper thickness for the shell. Then the concrete for the flow line was laid, in a strip about 2 ft. wide, between rails as in sidewalk work, the proper radius being given by a straight-edge drawn over templets. In the side rail notches were cut the required distance apart to hold the other reinforcing rings, to which latter the longitudinal rods were fastened by wiring.

We used plain rods, twisted rods and lug bars. Our experience showed that the lug bars were the best of the three, as they were easier maintained in position. But this method of reinforcement, although affording ample strength, was tedious to place and hard to keep placed, and after thoroughly trying it, a change was made to expanded metal, which speedily proved itself much superior in these respects. This was made in two sheets, one 3 in. mesh No. 10 standard (No. 16-3 Uniform Standard) for the lower half of the sewer and the other 3 in. mesh No. 10 plus 50% (No. 25-3 Uniform Standard) for the upper half, both bent to the required radius, and long enough to afford plenty of lap at spring line. For this portion, "Blaw" collapsible semi-circular forms were used. The method of operation was as follows: The trench having been shaped as nearly as possible to fit the outside of the sewer barrel, the concrete flow line was placed, without using any side rails, and brought up to 2 in. below the grade line; then the sheet of expanded metal placed thereon, and the concrete brought up to the grade line, the proper shape and grade being given by cutting off with a straight edge, resting on heavy blocks, cut to the required radius and placed about 16 ft. apart, or the length of a convenient straight edge. After the concrete has set sufficiently usually the next day, the lower semi-circular form was placed thereon, and the concrete filled up to the spring line, the walls of the trench forming the outside casing of the concrete. When this was set, the forms were pulled ahead onto the next section of flow line, and the upper forms placed; the sheet of reinforcing metal bent to the right radius, and put around the form, being kept 2 in. inside the concrete by a piece of brick 2 in. thick, resting on the form. These "Blaw" forms were 5 ft. long and were coupled 10 together, making 50 ft. in length. After the work had progressed enough so that things became systematized, the usual schedule for the day was as follows: (1) Releasing forms from the invert constructed the day before and

placing them on the flow line laid the day before; (2) releasing arch forms and pulling ahead on to the invert; (3) concreting the arch; (4) concreting the invert in the section ahead; (5) concreting 50 ft. of flow line ahead for the next day.

Another sewer 54 in. in diameter, was built in horse-shoe shape, semi-circular arch, vertical sides and bottom slightly V shaped. It was in an open ditch or water course, so nearly all except the flow line was above ground, and outside forms were necessary, in the absence of the trench walls, to hold the concrete. First the bottom was laid as in sidewalks, and the vertical sides run up to the spring line with ordinary plank inner and outer forms, the expanded metal reinforcement having been bent and placed as before, with plenty of lap at the spring line. The arch was put on with a semi-circular "Blaw" form. On all these monolithic jobs the average labor hours per lineal foot for the different operations of constructing the sewer, using "Blaw" forms and expanded metal reinforcement, is given in the following table. Knowing the wages paid labor per hour and the price of materials, this will be some guide to the cost in other places:

Labor hours per lineal foot.

Placing flow line	0.48
Setting invert forms	0.50
Concreting invert	0.44
Setting arch forms	0.33
Concreting arch	0.25

At first, house connections were provided for by building in ordinary vitrified slants or thimbles but the flanges of these were frequently broken by fallen rock and otherwise, so a change was made and an opening left in the concrete shell by means of a special form or core, devised by Mr. D. B. Davis, inspector on the work. This comprised two circular blocks of hard wood, nailed together; one 8 in. diameter and 2 in. thick, the other 6 in. in diameter and 3 in. thick. Inserted in the concrete this left a good flange to receive the end of the 6 in. house connection pipe, and was extremely inexpensive, two blocks lasting the season.

All these different procedures have given an excellent opportunity of judging the relative merits of monolithic and concrete pipe. In ordinary cases the monolithic is undoubtedly the cheaper, and in workmanship and durability can be made first class. Probably it can be made more nearly water tight than the joints of the pipe. Tamping under the lower quarters of the pipe is necessary, but is difficult to do and evidently cannot be as solid as the monolithic with the concrete built right against the bank. Monolithic requires a less width of trench, as the cutting is made the exact dimension, while the pipe needs a ditch several inches wider in order to enable the tamping to be done under and around it. On the other hand, the monolithic requires the laying of a subdrain tile to carry the water underneath the work. This was done on all our sewers. An ordinary 6 in. soft drain tile laid in the bottom of the trench carried the water away without any trouble, in most cases, and abundantly justified its cost. But when exceedingly treacherous soil is encountered or if it is necessary to do the back-filling immediately the concrete pipe would be the most advantageous. Also the latter can be made on the bank or elsewhere in more favorable conditions and under better and more careful superintendence, whereby better work could be obtained. There is doubtless a field of usefulness for both methods, and the local conditions must determine the better.

THE RIVERSIDE PORTLAND CEMENT PLANT.

We failed to give credit for designing the new Riverside Portland Cement Mill at Riverside, Cal., which was written up in our May issue, to Mr. C. L. Carman. "The plan of our mill," says John G. Treanor, general sales agent of the company, "was strictly his design and that the plant has started off and has run like an old mill is due to its excellence of design, selection of parts and good workmanship, but principally is it due to the perfection of design of the various details."

The crushers were furnished by the Austin Mfg. Co. of Chicago; cars in which the clay is brought into the plant are manufactured by the Kilbourne & Jacobs Co. The capacity of the clay storage is 20 days at 2,000 barrels per day.

There is a screen between the No. 8 and the No. 4 crushers.

The stone from the crushing plant does not go to the dryers and then to storage. It goes to either or both, but not through the dryer and then to storage. It does go, however, from the dryers to the ball mills, and is taken from storage to dryers at night, or when the crushers are shut down, and passed through them on its way to the ball mills.

The kilns were furnished by the Vulcan Iron Works, Wilkes-Barre, Pa., and leather belting by the Page Belting Company. There are about eighty motors in the plant which also operate the water pumps.

TRADE NOTES.

The city of Kansas City, Mo., has adopted cement sewer pipe in competition with clay pipe.

Chickasha, Okla.—The Chickasha Cement Burial

Co. has been organized by J. A. Rose, F. M. Frey, E. S. Dugan

Plainfield, Ia.—J. J. Hullman is considering the question of installing a cement block factory here.

Toronto, S. D.—Lauris & Peter Larson and Gus Anderson have established a plant for the manufacture of cement goods, using a thresher engine for power.

Fox Lake, Wis.—J. C. Williams and John Rogers have opened a cement block plant.

Neenah, Wis.—R. O. Sindahl is introducing the construction of block cement sidewalks here.

Lewiston, Idaho.—The Lewiston Glazed Pipe Co. has been organized recently to manufacture cement pipe for irrigation purposes.

Biggsville, Ill.—The Biggsville Cement & Block Works will have a capacity of 12,000 cement brick per day. James Kilgore is at the head of the company.

Arthur D. Little, Inc., have recently been conducting an extensive test upon the gas engines and producers of the Texas Portland Cement Co., at Dalles, Texas. This test was conducted by the following gentlemen: Messres. D. T. Randall, J. G. Gallan, C. H. Jumper, and A. D. Camp, for about a month upon a power plant of 3,000 H. P. rated capacity. The somewhat unusual feature connected with this work is the fact that lignite is used by this plant for fuel.

The very rapidly increasing and varied uses of concrete for all types of structures for manufacturing purposes make any addition to the general fund of information valuable to mill owners and managers and to engineers, architects and contractors. For this reason the report of the investigation of the Aberthaw Construction Co., of Boston, Mass., on "Wearing Surfaces for Factory Floors" has been published and they will be very pleased to supply anyone interested in the subject with a copy of the treatise.

NEW BOOKS

The Manufacture of Hydraulic Gypsum and Other
Gypsum Products - - - - - 50 Cents

By M. Glasenapp

The Hardening Process of Hydraulic Cement }
The Hardening of Cement Under Water } - 50 Cents Each
The Constitution of Hydraulic Cements }

By Dr. W. Michaelis, Sr.

How to Use Portland Cement - - - - - 50 Cents

Cement Sidewalk Construction - - - - - 50 Cents

Hollow Concrete Building Block Construction - - - 50 Cents

Monier Cement and Steel Construction - - - - - 50 Cents

Handbook of Reinforced Concrete Construction, paper cover 50 Cents

By L. J. Mensch

Delivered Free on Receipt of Price.

Address **CEMENT & ENGINEERING NEWS**
22 Fifth Avenue, Chicago

CEMENT MILL NEWS.

A few days ago the great three hundred-horse power engine of the San Antonio Portland Cement Company, San Antonio, Texas, was started, which means that in a few weeks the company will begin the manufacture of hydraulic cement at the rate of 800 barrels a day, which will be gradually increased until a full complement of 2,000 barrels daily will be manufactured. Work on this new mill was started about a year ago.

The Hecla Cement Co., Boy City, Mich., is experiencing one of the best seasons since it began operations. The market is exceptionally good this year and the installation of a new dryer and a general overhauling of the machinery has placed the plant in the best possible condition for the run. The capital of this company was increased the other day from \$1,000,000 to \$1,500,000.

The Pennsylvania Railroad tells the Interstate Commerce Commission that it does not discriminate against Philadelphia in its rates on cement. The company charges \$1.35 a ton for carrying cement from the Lehigh district to this port. It carries cement from the same district to New York harbor, twenty-four miles further on its railroad lines, for 80 cents a ton. But this is not discrimination, the company goes on record as believing.

W. H. Simmons has been appointed superintendent of the New Aetna Portland Cement Co., Fenton, Mich., in place of E. M. Bunce. Mr. Simmons is an analytic and consulting chemist and has for some time made his headquarters at Fenton.

The inability to secure cement quickly in towns along the Illinois river has started talk of a barge line being put in service on the stream to carry the finish product from the mills of the Marquette and German-American Portland Cement Companies to neighboring cities.

G. G. Rehfield who was formerly connected with the Chicago Portland Cement works at La Salle, Ill., as electrician, it is reported, has accepted a place as engineer and general superintendent of a new cement plant at Gardner, Mont.

The Allis-Chalmers Company has just secured from the United States Steel Corporation additional orders for six gas engine driven electrical units which will increase the Corporation's power plant at Gary, Indiana, 25 per cent. The twenty-five engines which the Allis-Chalmers Company has installed in this plant, and the order just secured, will make a total of thirty-one gas engines with a combined capacity of 150,000 horse-power, which will be the largest power plant of its kind in the world. These units will operate on blast furnace gas.

In addition to this the Allis-Chalmers Company has secured from the American Steel & Wire Company an order for two large gas engines for its Central Furnaces at Cleveland, Ohio, of the same capacity as the engines for the Gary plant.

RECEIVER FOR NORTHAMPTON.

H. Allen Schaffer has been appointed by the United States district court at Philadelphia as receiver for the Northampton Portland Cement Company, Stockertown, Pa. The petition was made by these creditors: John W. Cutter, \$10,000; Walter W. Lee, \$10,000; Frank C. Pringle, \$10,000. The company was incorporated in March, 1900, with a capital stock of \$900,000, and since then first and second mortgage bonds have been issued, of which it is said about \$360,000 are outstanding.

PECK CARRIER

THE STANDARD MACHINE FOR HANDLING

Cement, Crushed Rock, Hot and Cold Clinker, Coal, Etc.



One of five PECK CARRIERS at the Sandusky Portland Cement Works, Dixon, Ill., to handle clinker, coal and rock. View shows horizontal run with bucket tilted for emptying into bin.

Send for our book—the Peck Carrier; the proper method of conveying is explained supplemented by graphic diagrams and detail illustrations.

LINK-BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

NEW YORK, PITTSBURGH, ST. LOUIS,
299 Broadway, 1501-2 Park Bldg. Central Nat'l Bank Bldg.

SEATTLE,
439-440 N. Y. Block.

DENVER,
Lindrooth, Skubart & Co.

NEW ORLEANS,
Wilmot Machinery Co.

SAN FRANCISCO—Eby Machinery Co.

USE

Portable Tracks As Feeders

to your permanent tracks. Quickly laid, extended and transported. Save you many times their initial cost. Can be moved around as easily as a man can carry a pick and shovel.

Write for valuable cost data on "CONCRETE MAKING"

ORENSTEIN- ARTHUR KOPPEL COMPANY

General Offices

PITTSBURGH, PA.

New York

Chicago
San Francisco

Baltimore
Denver

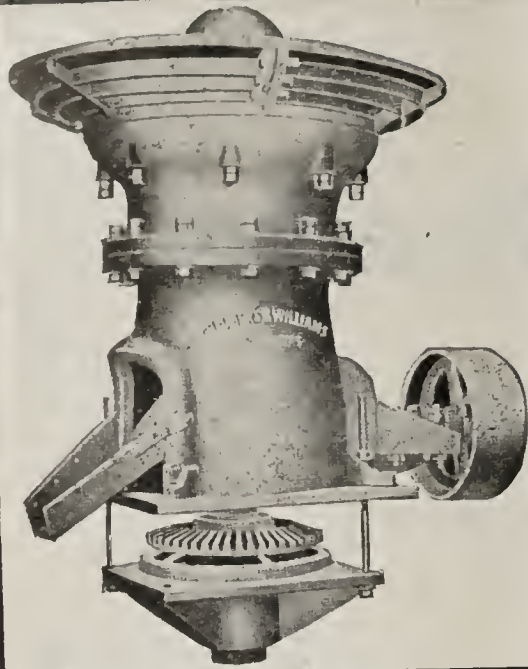
Boston



BECAUSE of its peculiar formation and self-furring features ---
"Cleveland" Expanded Metal Lath is especially adapted to
exterior stucco work.  Write Us for Samples and Prices or Further Information

THE GARRY IRON & STEEL COMPANY

NILES, OHIO



Kennedy Gyratory Crusher

The only Crusher built with a ball and socket eccentric which will lend itself to any change in the inclination of the main shaft. Improved hopper, more efficient dust collars.

— ALSO —

Cement Making Machinery

Kilns, Dryers, Tube Mills, Ball Mills, Elevators, Conveyors, Feeders, Revolving Screens and Crushing Rolls.

Chalmers & Williams Inc.

1927 Commercial National Bank Building, - - - Chicago
120 Liberty Street, New York

Allis-Chalmers No. 21 Rock and Ore Breakers

"THE LARGEST BREAKERS EVER BUILT"

These breakers are designed to fill the demand for machines with a large receiving opening and for use in crushing plants producing large quantities of crushed stone. They are proportioned so as to obtain the maximum of strength and rigidity.

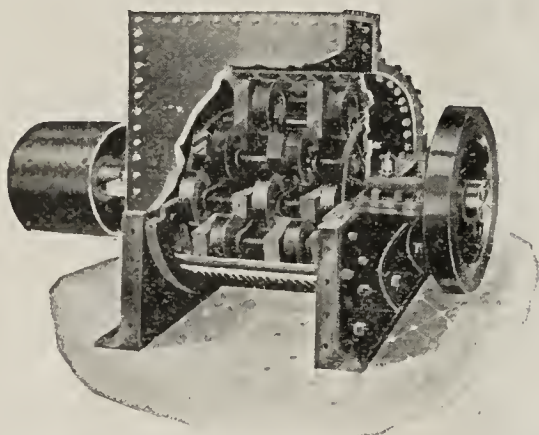
Write for Description, Prices, etc.

GENERAL
OFFICES

ALLIS-CHALMERS CO

MILWAUKEE
WISCONSIN

American Ring-Hammer Pulverizer



Six Sizes.

will pulverize

Cement, Clinker, Shale, Limestone, Coal, Etc.

30 days' working test at your works allowed. Machines guaranteed.
All Grinding Parts Made of MANGANESE STEEL.

Write for particulars and circulars.

AMERICAN PULVERIZER CO.

410 JACCARD BUILDING

ST. LOUIS, MO.

Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

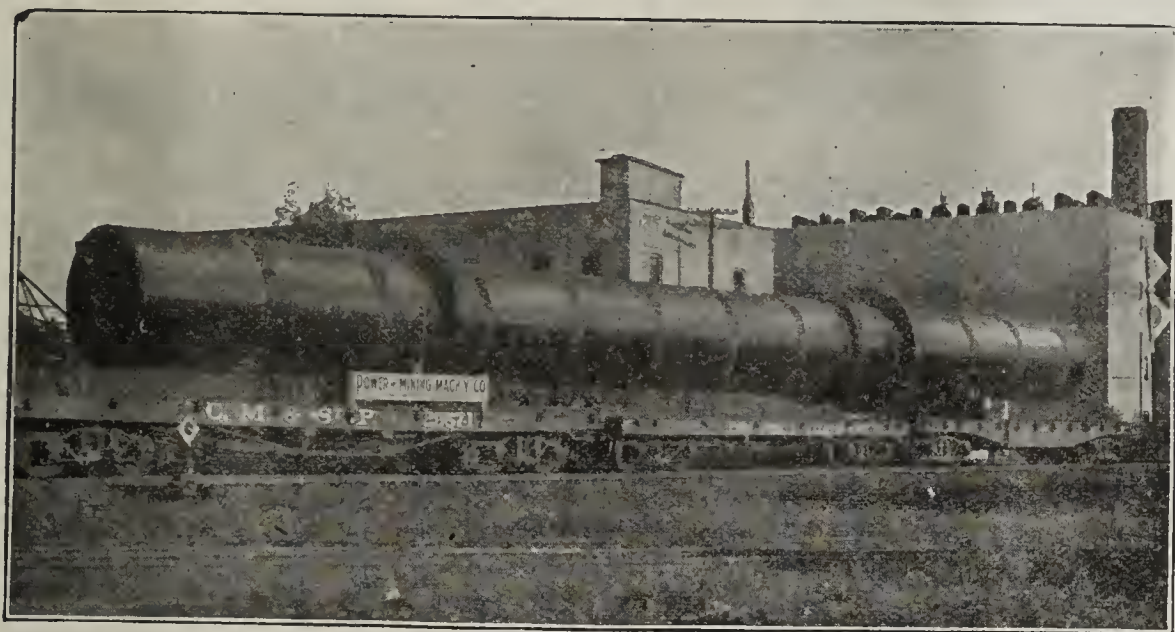
Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - - - 645 No. Sixth St., Terre Haute, Ind.

Cement Mill Machinery

A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process.

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



Write for Catalogue No. 17.

Power & Mining Machinery Company

MILWAUKEE, WIS., U. S. A.

CHICAGO.

NEW YORK.

ATLANTA.

EL PASO.

SAN FRANCISCO.

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

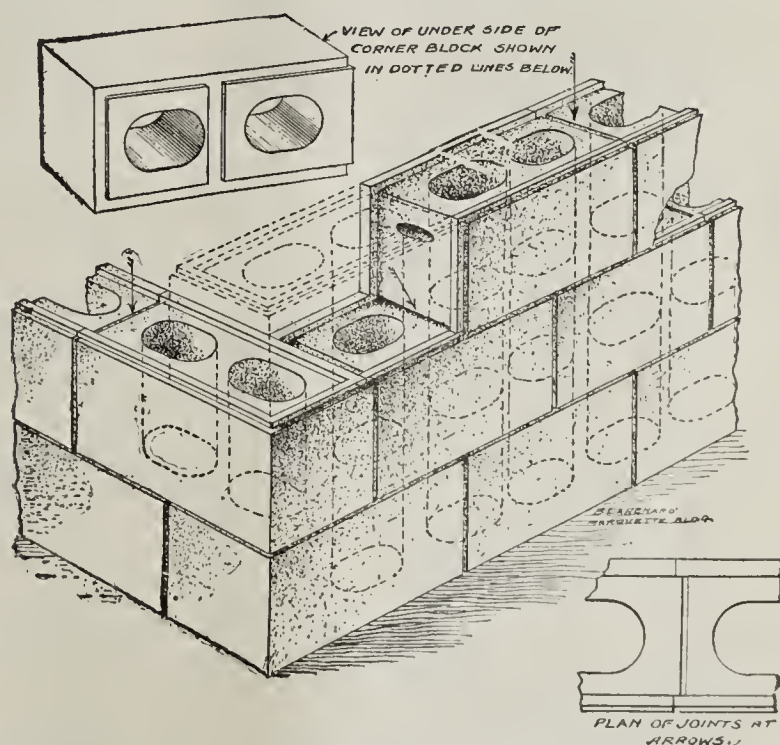
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting Face-Down Machine by the Wet Process

The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

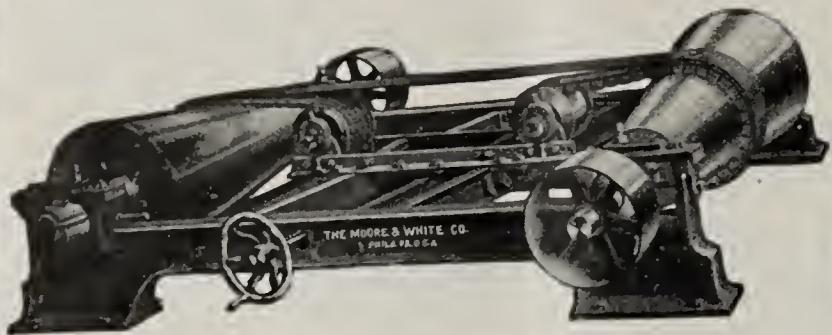
Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and agents wanted in all states and foreign countries.



DIAMOND CONCRETE MACHINERY COMPANY

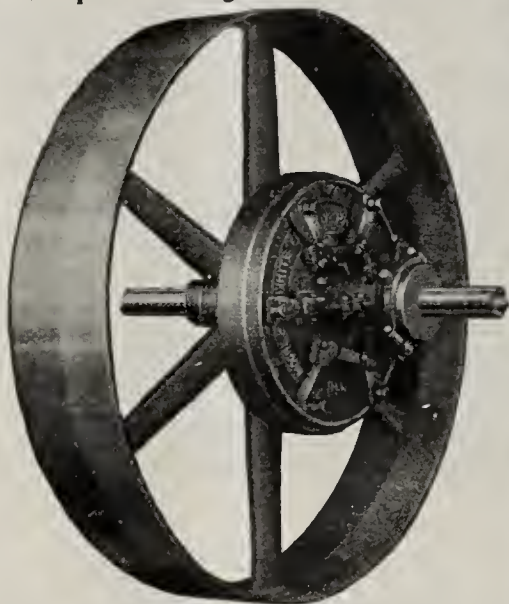
CARDINGTON, OHIO

It will be to any Mill Owner's advantage to investigate these two economical Power devices.



M. & W. Speed Change.

Power
Transmission
Machinery
for
Cement
Mills.



Write for

Catalogue.

Friction Clutch Pulley.

The Moore & White Co.,
Philadelphia, Pa.



Uniformity

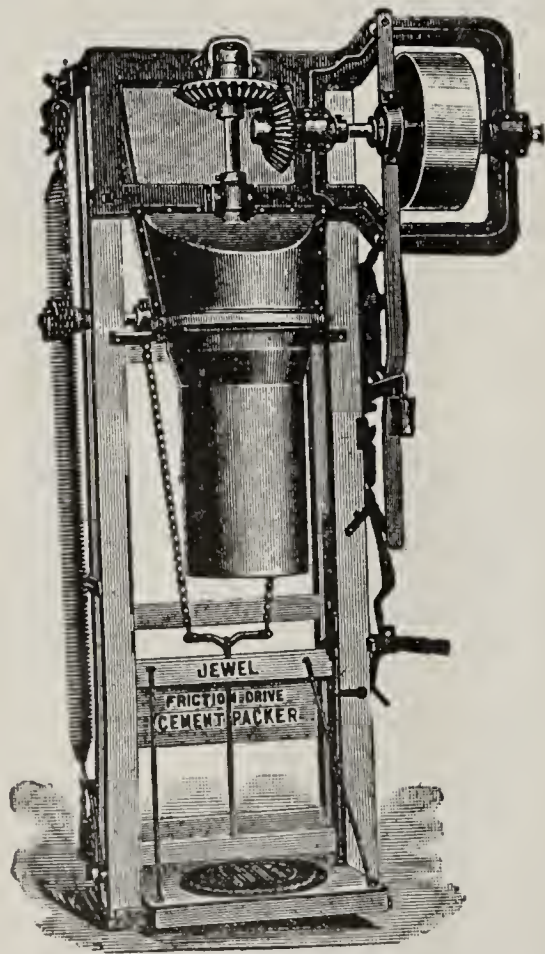
Perfect uniformity in all those properties which make Portland Cement of the highest quality distinguishes Universal Portland Cement. Absolute uniformity in soundness, strength, fineness, color and setting qualities is secured by the use of materials, methods and devices representing the highest perfection in the manufacture of Portland Cement.

Universal Portland Cement Co.

Chicago—Pittsburg

Annual Output 8,000,000 Barrels

There is more Cement being packed by the "S. HOWES" Company's Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and sacks.

The "JEWEL" FRICTION driven cement Packer, specially constructed for rapidly packing sacks.

Both machines are equipped with friction pulleys, heavy iron frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company
SILVER CREEK, N. Y.

Apparatus for Chemical and Physical Testing of Cement

EIMER & AMEND

205-211 Third Avenue, New York City

MANUFACTURERS OF & HEADQUARTERS FOR

Chemical Apparatus, C. P. Chemicals and Reagents

Cement Briquette Moulds.

Gilmore Needle.

Standard Sieves of Exact Meshes.

Williams' Sp. Gr. Balance.

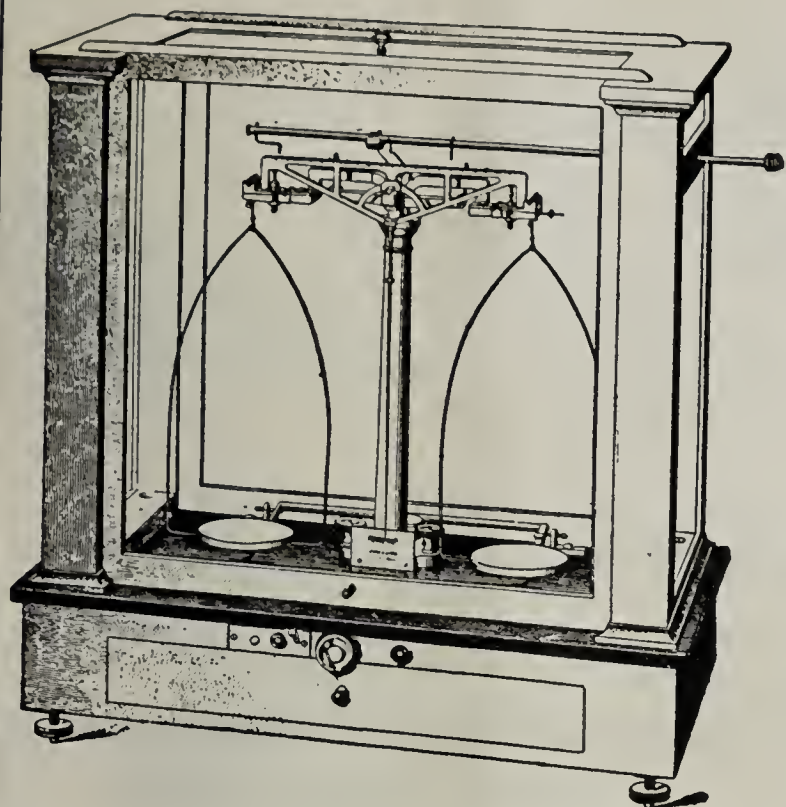
*Specially adapted for determining
Sp. Gr. of Cement.*

(Descriptive Pamphlet sent on request)

*Schumann's, Le Chatelier's,
Jackson's and Candelot's
Apparatus for Sp. Gr. of
Cement.*

Headquarters for **Calorimeters and Pyrometers.**

(Our large illustrated Catalogue gladly sent to Chemists on application.)



F. A. Jones, M. E.

Gypsum Specialist

Consulting Mechanical, and Chemical Engineer, in
Designing Construction, and Operation of Plaster Mills,
Mines, and Mixing Plants.

Plans, Specifications, Estimates of Cost, Superinten-
dence of Construction, ROTARY or KETTLE PROCESS.

Examination, Tests, Analysis, and Reports of Gypsum
Properties, Mills Remodeled and Enlarged, Mixing
Plants Erected, and Formulas Furnished.

883 Mahoning Avenue

YOUNGSTOWN, OHIO

WM. B. SCAIFE & SONS CO.

221 First Ave., Pittsburg, Pa.

WE-FU-GO

and **SCAIFE**

Water Softening, Purifying, and Filtering Systems

— FOR —

BOILER FEED

AND EVERY INDUSTRIAL USE.

Send for Complete Information

DEXTER Portland Cement
THE NEW STANDARD

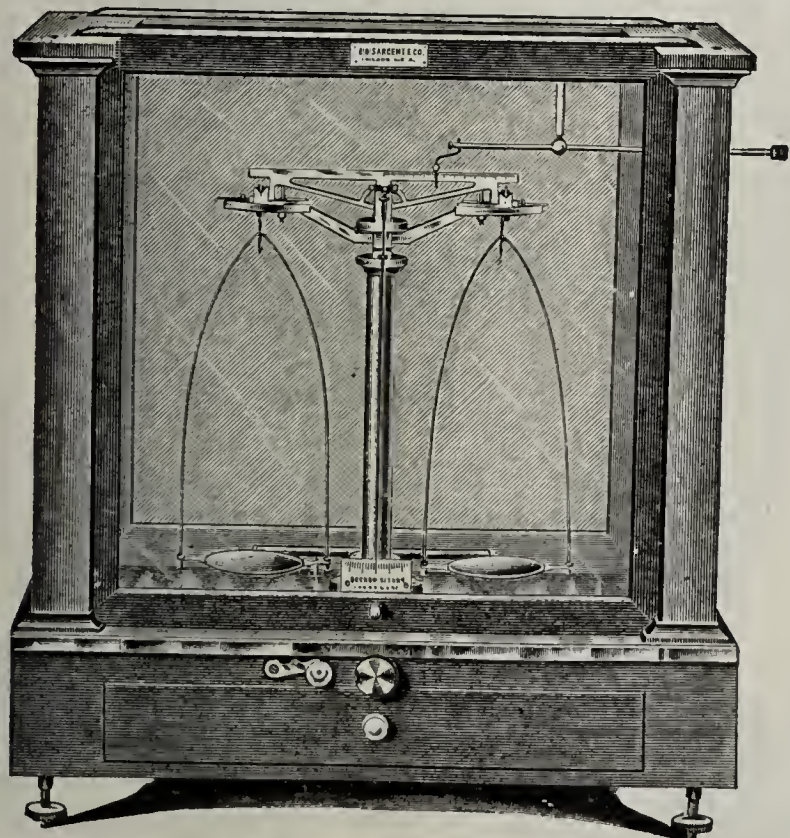
Sole Agents **SAMUEL H. FRENCH & CO.** Philadelphia



HAVE YOU AN IDEA?

If so write for our books: "Why Patents Pay," "What to Invent," "100 Mechanical Movements" and a Treatise on Perpetual Motion—50 illustrations. All mailed free.

F.G. DIETERICH & CO. Patent Lawyers
and Experts
801 Ouray Block WASHINGTON D. C.



E. H. SARGENT & CO.

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN

CHEMISTS SUPPLIES

Of high grade only.

We call particular attention to our Cement
Mould, Vicat Indenting Apparatus, as im-
proved by us, Gilmore's Needles, Jackson's
specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

CHICAGO



McCaslin Conveyor over Storage Bin Handling Hot Clinker

The McCaslin Conveyor

Acknowledged by Competent Engineers as the best Conveyor in the world for handling hot clinker, stone, etc., in **CEMENT PLANTS.**

Low Cost of Maintenance Absence of Shut Downs
Maximum of Efficiency

Manufactured solely by

Mead, Morrison Mfg. Co.

BOSTON

NEW YORK

CHICAGO

Catalog on Request

Send Us Your Specifications for an Estimate

Face Your Blocks

Make Them White

Do You
Use

WHITE SAND

Leading contractors specify our pure White, Washed and Screened Silica Sand for fine work in ornamental stone, block facing, porch work, ornamental lawn fixtures, vases, etc.
This sand is shipped both DRY and DAMP.
Prices and Samples on request.

BALLOU'S WHITE SAND COMPANY
MILLINGTON, ILLINOIS

Hess Furnaces



No. 45

"Leader" Hess
Steel Furnace

Price **\$49.00**

Delivered East of Omaha and
North of Ohio River
Pipes and Registers Extra

for the past 7 years, have been sent to customers in every state in the Union, freight prepaid,

On Approval

and the money held back till sixty winter days of actual trial have proved that all our claims for superiority have been fulfilled.

Isn't this worth looking into? Could we offer such liberal terms if we didn't know that the Hess Furnace excels in service, simplicity, efficiency, economy?

All we ask of you, if you need a furnace, is to investigate—to put your name on a postal card, mail to us and ask us for our booklet "Modern Furnace Heating." This booklet is an authority on furnace heating, and copies have been requested by many colleges, libraries, etc., for reference in engineering and mechanical courses. It instructs fully in the principles and practice of furnace heating, and should be in the hands of every builder and house owner. It is free on request.

In Buying Direct

From Our Factory You Pay Only One Profit—A Small, Factory Profit.

Our prices are not inflated with the usual cost for salesmen, branch stores, agents' and dealers' profits. The factory profit only, satisfies us, and you will be surprised at how much we can save you.

Special Heating Plan Free Before You Order

Let us have our experts prepare a special plan for heating your building. It will cost you nothing, and put you under no obligation to buy of us. Our thirty-six years of experience in designing heating equipments makes this free plan valuable to you.

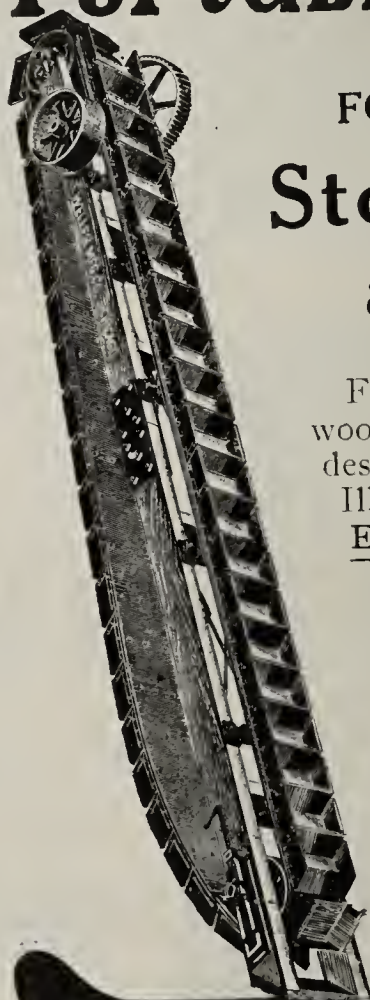
Ask us more about it. A postal card today will serve the purpose.

Hess Warming & Ventilating Co.
919 Tacoma Bld., Chicago.

Portable Elevators

FOR HANDLING

Stone, Gravel and Cement



Furnished in all designs, with wood or iron frames, and of any desired capacity.

Illustration shows a WELLER-Made Portable crushed stone elevator; we furnish these for handling all classes of materials.

Send for 512 page catalog on WELLER-Made Elevating, Conveying and Power Transmitting Machinery.

Weller Mfg. Co.

CHICAGO

WELLER-Made

The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa

WANT COLUMNS.

Advertisements in this column are inserted at the rate of two dollars per inch per issue—and no advertisement will be taken for less than two dollars and must be paid strictly in advance.

POSITION WANTED.

Assistant Chemist (Lehigh University), desires position. Am also a first class accountant. Four years' experience. Address Chemist, 330 Fourth St., South Bethlehem, Pa.

WANTED.

If you are interested in pumps of latest and best styles, send to us for book and catalogue. Pumps of all styles and for all uses. The Columbus Steam Pump Works, West Broad street, Columbus, Ohio.

CHEMIST

With ten years successful experience, eight years as Chief Chemist, desires change of present location. First class references furnished from past and present employers. Address W., care Cement & Engineering News.

"PLASTER OF PARIS"

American Patent No. 757649 dated April 19th, 1904.

FOR SALE.

This method produces a much better quality than other methods and there is a great saving in the cost of production. The German Patent has been sold and the process can be seen working in England. Apply DUNN BROS. & CO., Manchester, England."



TRADE MARK

PENINSULAR PORTLAND CEMENT

Acknowledged by competent Architects and Engineers to be unequalled for fineness, wonderful development of strength and sand carrying capacity.

"THE BEST IS THE CHEAPEST"

Address

Peninsular Portland Cement Co.
JACKSON, MICHIGAN.

Fire Brick Linings For Cement Kilns

STANDARD TESTING SAND AND
GENERAL BUILDING SUPPLIES

Garden City Sand Co.,
188 Madison St., Chicago

Location for Cement Plant

Extensive Deposits of Raw Material. Proximity to Large and Growing Markets. Low-Priced Fuel Supply.



THERE ARE several desirable locations for Portland Cement Plants along the Santa Fe, where the advantages enumerated are to be found. If you are interested you can secure full and detailed information by addressing this office.

The SANTA FE is glad at all times to co-operate with those seeking locations or desirous of investigating conditions in territory tributary to its line. Correspondence from interested manufacturers is invited.

WESLEY MERRITT, Industrial Commissioner A., T. & S. F. Ry.
1122 Railway Exchange Building
CHICAGO, ILL

The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker
1½ inches diameter from the kiln
and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

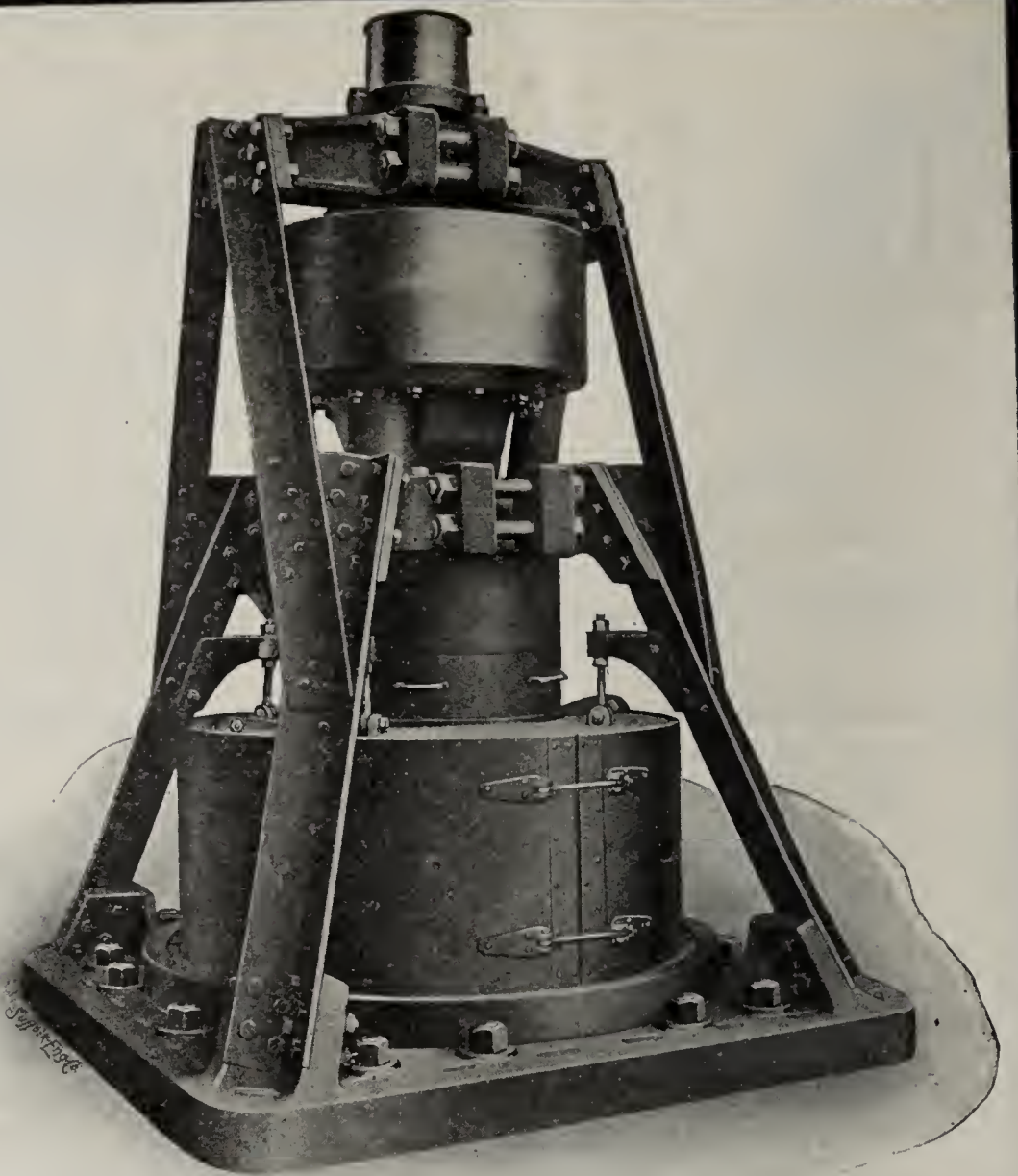
It saves cost in attention.

MANUFACTURED BY

BRADLEY PULVERIZER CO.

37 Walbrook
LONDON, E. C.

92 State Street
BOSTON



ALPHA

PORTLAND CEMENT....

Alpha, N. J.
Works: Martins Creek, Pa.
Manheim, W. Va.
Alsens, N. Y.

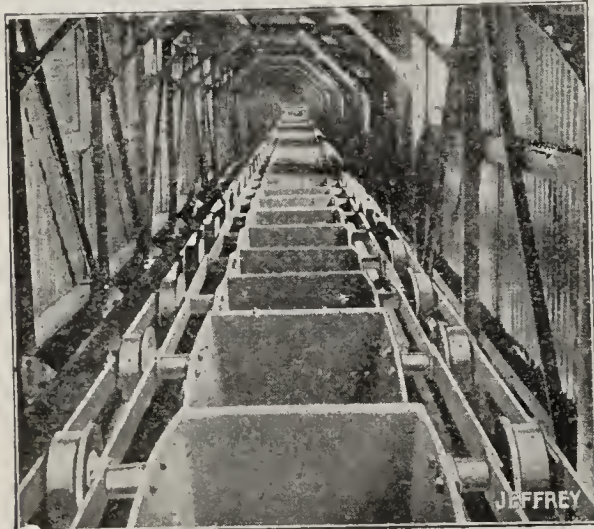
Quality
unexcelled

The Recognized Standard
American Brand

Always
Uniform

ALPHA PORTLAND CEMENT CO.

Manufacturers of but one grade—strictly straight Portland
General Office, EASTON, PA.



Conveyers

For HANDLING CRUSHED
STONE, CEMENT, COAL,
CLINKER, ORES, Etc.

¶ We furnish the most economical and reliable systems obtainable and are prepared

to quote the lowest prices consistent with the highest grade materials and best workmanship. ¶ They are designed and built in styles and capacities for any practicable requirements

*Let us figure on a modern equipment
for your requirements. Catalog Aa 81
illustrates many systems in operation.*

THE JEFFREY MFG. CO.
COLUMBUS, OHIO.

LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GROUND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.,
ALLENTOWN, PA.

Western Office:
725 ROCKEFELLER BUILDING,
CLEVELAND, OHIO.



THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

Design, Construction, Remodeling and Operation
of Portland Cement Plants

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street New York Canadian Express Bldg., Montreal, Can. 1121 The Rookery Chicago 425 Washington St. San Francisco, Cal. Monongahela Bank Bldg. Pittsburgh Syndicate Trust Bldg., St. Louis, Mo. Norfolk House, Cannon St. E. C., London

The Osborn Engineering Co. Civil, Mechanical and Electrical Engineers
Experts in the Designing of
CEMENT PLANTS.
OSBORN BUILDING, CLEVELAND, O.
Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of Cement Machinery

42 NORTH 16TH STREET

:-:

PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

COMMERCE BLDG.,
Kansas City, Mo.

Cement Engineers

Just Out!

Architects' and Engineers' Hand Book on
Reinforced Concrete
Construction

ONLY ONE DOLLAR

CEMENT & ENGINEERING NEWS

22 Fifth Avenue, - - - Chicago

Colonial Trust & Savings Bank

A BANK FOR THE PEOPLE

Pays 3% on Savings Accounts

Capital and Surplus, \$1,106,620

YOUR ACCOUNT INVITED

205 La Salle Street, - - - - - Chicago, Ill



THE IMPROVED DIETRICH'S CLAMP

and

Form System for Hollow Walls

By the use of the Improved Dietrichs Clamp and Form System for Hollow Walls the

**COST OF CONCRETE
CONSTRUCTION IS
REDUCED 50%**

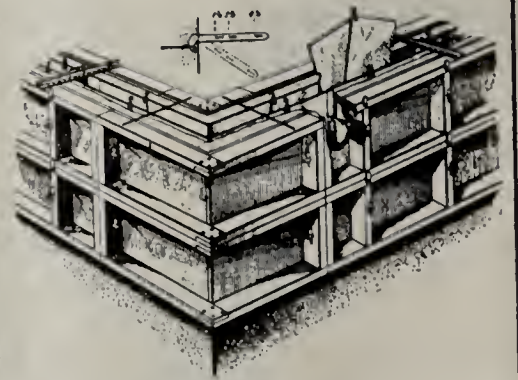
and the builder also secures a

**PERFECT
DAMP-PROOF WALL**

This system is based on the panel principle and employs removable sheet iron inner forms with sheet iron spacer. Corners, doors and window openings are provided for.

Write for pamphlet giving full information

DIETRICH'S CLAMP CO.
LITTLE FERRY, N. J.



ELEVATING-CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys,
Shafting, Shaft Bearings, Link Belting, Special Chains



HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES.
Catalog for the asking.

SKILLIN & RICHARDS MFG. CO., CHICAGO

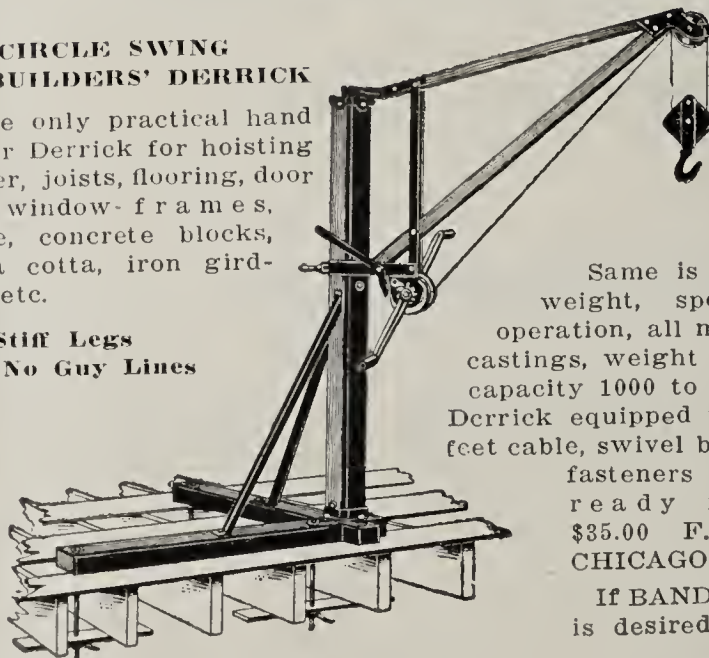
THE SASGEN BUILDERS' DERRICK

The Latest Inventions in
HOISTING APPARATUS

Our CIRCLE SWING BUILDERS' DERRICK

is the only practical hand power Derrick for hoisting timber, joists, flooring, door and window frames, stone, concrete blocks, terra cotta, iron girders, etc.

No Stiff Legs
No Guy Lines



Same is light in weight, speedy in operation, all malleable castings, weight 250 lbs.; capacity 1000 to 1500 lbs. Derrick equipped with 110 feet cable, swivel block and fasteners complete ready for use. \$35.00 F. O. B. CHICAGO.

If BAND BRAKE is desired, add \$1

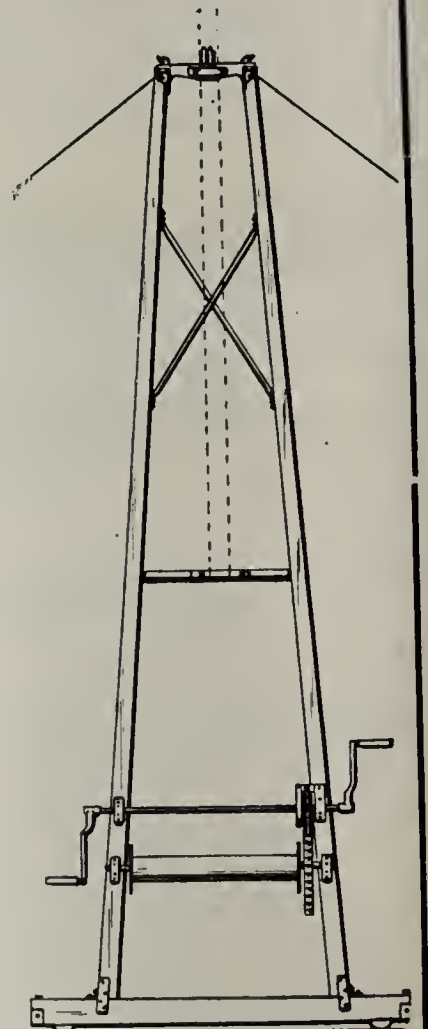
We keep all these machines in stock and can fill orders promptly.

SASGEN BROS.

2053-57 Racine Ave., - - - CHICAGO, ILL.

New York Office, 103 Park Ave.

— Write for Illustrated Catalogue "C" —



OUR SASGEN IMPROVED SETTER DERRICK including a top shive frame, extension clamps, etc. Price of 20 ft. lengths \$42.00 F. O. B. Chicago.



OUR POLE DERRICK is built light and strong. Average length 18 ft.; weight 200 lbs.; capacity 1800 lbs.; equipped with 100 ft. cable block and rollers ready for use \$26.50 F. O. B. Chicago.

Tombstone and Burial Vault Moulds

Did you ever stop to consider the big profits in this line? This mould can be made for \$2.00 and sold for \$25.00. Block Making is confined to certain territory but grave stones can be shipped anywhere with profit.

Do You Know

that special facing can be secured to produce imitation of granite, and other attractive finishes? We tell you how to make the moulds and also how to get the business. Send today for our catalog.



Big 1910 Wholesale Catalog

Our 1910 Publication

should be in the hands of everyone interested in concrete. It tells all about this industry and shows complete line of designs for this purpose. Everything imaginable is listed and we are making wholesale prices.

Don't delay. Send to-day for a copy which will be mailed to your personal address free.

Northwestern Steel & Iron Works, Box 824, Eau Claire, Wis.



Medusa White Portland Cement

Used for entire exterior plaster of Ritz Hotel, San Francisco, Cal., here illustrated.

A beautiful product adapted to ornamental artificial stone work of the highest grade. Equal or superior to any other White Portland Cement known.

Write for free sample, pamphlet with instructions for use and price.



MEDUSA WATERPROOFING

(Patented Apr. 23, 1907)

Makes concrete impervious to water and prevents efflorescence and discoloration. Gives absolutely permanent results and does not affect strength, setting or color of Portland Cement.

Used by nearly all the foremost Engineers, Architects, Railways, Contractors, Block Makers and Cement Experts.

Obtain our price and circular, also price on Medusa Gray Portland Cement.

SANDUSKY PORTLAND CEMENT Co., Sandusky, O.

"EXPENSES DIMINISHED"

"MEANS PROFITS INCREASED"

ROCK CRUSHERS.

1—9 x 15 Allis Chalmers Jaw Crusher.

ROCK DRILLS.

6—Ingersoll-Sargeant Rock Drills, size 3 1/4 inches.

6—Ingersoll-Sargeant Rock Drills, size 3 1/2 inches. Fitted for steam or air.

HOISTING ENGINES.

1—12x16 double cylinder, heavy duty LIDGERWOOD hoisting engine.

1—6x8 Marine Iron Works double cylinder, single drums, reversible in steam chest.

PUMPS.

3—24 inch Centrifugal pumps, 2 to 3,000,000 gallons capacity.

1—20x13x12 Wheeler & Tappen Duplex Pump.

IRON PIPE.

70,000 ft. 1 inch Standard Pipe, 35,000 ft. 1 1/4 inch Casing.

5,000 rolls rubber, leather and canvas belting, structural iron, shafting, pulleys, couplings, steel wire and manila rope. Smoke stacks, corrugated roofing and siding, hose hydrants, tanks. We can save you money on anything you require.

SEND FOR OUR NEW 500-PAGE CATALOG NO. 962.

A wonderful book of facts and information of the utmost value to everyone. Send to-day. It will cost you nothing.

CHICAGO HOUSE WRECKING CO., 35th and Iron Sts., CHICAGO, ILL.

50,000 ft. 1 1/2 inch Standard Pipe, 40,000 ft. 3 1/4 inch Casing.

30,000 ft. 2 inch Standard Pipe, 60,000 ft. 3 1/4 inch Casing.

2,000 ft. 10 inch Standard Pipe, 8,000 ft. 5 1/2 inch Casing.

4,000 ft. 12 inch Standard Pipe, 9,000 ft. 6 1/4 inch Casing.

30,000 ft. 8 inch Cast Iron Pipe, 1,000 ft. 6 1/2 inch Casing.

300 ft. 24 inch Cast Iron Pipe, 1,250 ft. 8 1/4 inch Casing.

1,500 ft. Riveted Steel Pipe, 24 inch to 72 inch diameter.

ROOFING MATERIAL.

The latest and most modern product ever offered to the public. Our "Raw Hide Rubber Roofing" is without equal in durability and price. Will outlast the kind you have been using from 10 to 15 years and will cost you less. Is fire and weather proof. Send for our special book No. 180 on roofing; tells you all about it.

A CAREFUL COMPARISON OF OUR STOCK AND PRICES WILL DEMONSTRATE A SAVING TO YOU OF FROM 30 TO 75%.

SEND YOUR INQUIRY TO-DAY.

TANKS.

12—1,000 gallon capacity tanks.

42—1,500 gallon capacity tanks.

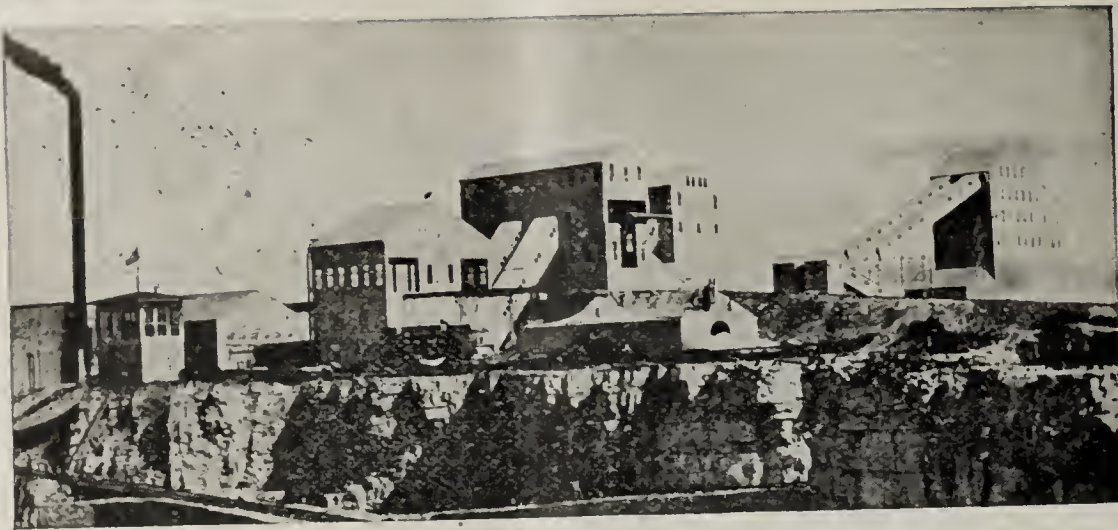
6—3,000 gallon capacity tanks.

15—3,600 gallon capacity tanks.

2—3,800 gallon capacity tanks.

STEEL STORAGE TANKS.

Capacity, 4,500 to 6,500 gallons. These tanks were used only a short time in railroad service. Very heavy construction—1/4" steel with 5-16" heads; domes in proportion to size of tank, and fitted with 15" screwed manhole. We will give them rigid inspection and paint before shipment. Prompt shipment can be made from points South, East and West.



Dolese & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world.
Machinery throughout installed by us.

OLSON BROS. & CO.

Engineers and Contractors

Cement Mill Machinery Erected, Stone Crushing
Plants Equipped and Erected. :: :: ::

ALSO COMPLETE PLANTS FOR HANDLING
COAL, SAND, GRAVEL, ORES, ASHES, ETC.

MODERN POWER TRANSMISSION
Elevating and Conveying Machinery.

Tanks and Vats, Especially in Connection with Machinery

2418-22 Bloomingdale Ave., Chicago

IRON-ORE CEMENT

The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of
mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in
place of Portland cement for all Marine Construction.

Send for Literature, Etc.

Worm-Cox Company
SOLE AGENTS

Marquette Building, Chicago

SPECIFY

Tisco Manganese Steel

FOR

Ball and Tube Mill Linings,
Gears, Pinions, Sprockets, Chain

IT LASTS LONGEST

TAYLOR IRON & STEEL CO.

HIGH BRIDGE NEW JERSEY

Peerless Portland Cement

MANUFACTURED AT UNION
CITY, MICH.

**Every Barrel
Guaranteed**

Fineness, Uniformity of Color
and Sand Carrying Qualities
equal to any Portland Ce-
ment Manufactured

German-American Port-
land Cement Works

OWL CEMENT

Illustrated Pamphlet Mailed on Request

E. L. COX, General Sales Agent,
1527 Marquette Bldg.,

Works: La Salle, Ill. CHICAGO

MEACHAM & WRIGHT CO.

Sales Agents

IMPROVED

UTICA HYDRAULIC CEMENT

And Dealers in

LEHIGH PORTLAND CEMENT

Telephone Main 59 206 La Salle St. Chicago

F. D. MEACHAM, Pres.
S. P. BLOUNT, Treas.

F. S. WRIGHT, Vice-Pres.
C. M. FOSTER, Secy.

Improved Canvas Stitched Belting



We Specialize in making Belts
for use in Cement Plants.

Light or Heavy Transmission,
Elevator or Conveyor Belts for
Wet, Dry, Hot or Rough condi-
tions.

Sawyer Belting Co.

Cleveland, O.

Send for Book "K."

"System" or Steel—Which?

We hear a great deal these days about "Systems" of reinforcing concrete.

And the popular inference is that by means of such "Systems" an economy of steel is effected.

Now the **fact** is that concrete is reinforced, **not with "system,"** but with **steel**; and—

In considering any claims regarding Economy of Steel, it is important to remember that the **amount** of reinforcement for a given load or span instantly and invariably reduces itself to a certain **area of steel** per lineal foot of slab cross section, **regardless of the type of reinforcement used.**

Whether you use **bar** reinforcement or some special "system," you are compelled to use exactly the same **area** of steel in either case, because—

The allowable working stresses in steel and concrete are limited both by engineering practice and by the building ordinances. Absolutely no provision is made for reinforcing concrete with "system" in lieu of steel.

It is only fair to say that, if the required area of steel of good quality be used, there is no objection to special methods or "systems" of reinforcement, **save one**, i. e.—

It costs more money to roll and fabricate steel for such "systems" than for bar reinforcement, and there is positively not the slightest advantage to justify the increased expenditure.

The **facts**, then, are these—(1) The best "system" can **never** be **better** than bar reinforcement. (2) Assuming that the same quantity and **quality** of steel is used in both cases, the additional expense of rolling and fabricating "system" steel makes it cost more. (3) Where lump sum bids are required it is obvious that the "system" proposition, if equal in price, must have less steel than the bar proposition. (4) Between two styles of reinforcement of exactly equal efficiency, the less expensive, i. e., **bar reinforcement**, should be specified.

We emphasize these facts, publicly, in the interests of a fair and clear understanding of the problem of steel economy, which, as will be seen, is clearly a question of **Steel Quality**:—

The Problem of Steel Economy Solved in the

M/B Special Open Hearth Bar (Cold Twisted) FOR REINFORCING CONCRETE

Prior to the M-B Bar, the engineer faced a dilemma, i. e.—

High-carbon steel, possessing great strength, and therefore requiring less steel, is **economical**, but brittle and likely to fail without warning.

Low-carbon or mild steel is **ductile**, therefore safe, but, on account of its low strength, requires a great excess of steel, and is, therefore, **expensive**.

So the best result obtainable was a somewhat doubtful straddle between **economy** and **safety**.

The advent of the M-B Bar made it possible to secure **economy** of design while conforming to the most rigid requirements of good engineering practice; for—

The M-B Bar is a superior steel, rolled from **new** billet stock, and **twisted cold**, combining both **high elastic limit** and **great ductility**.

While possessing an Elastic Limit of 60,000 lbs. per square inch, the M-B Bar can be **bent double while cold**.

The high elastic limit of the M-B Bar effects **Steel Economy** and the great **ductility** guarantees absolute safety of the structure.

M-B Bars, therefore, afford the cheapest known reinforcement for concrete.

M-B Bars cannot be purchased through Agents, but are sold by William B. Hough Company.

Send for our book of formulae and reinforcing data—"The Bar that Never Failed."

WILLIAM B. HOUGH COMPANY

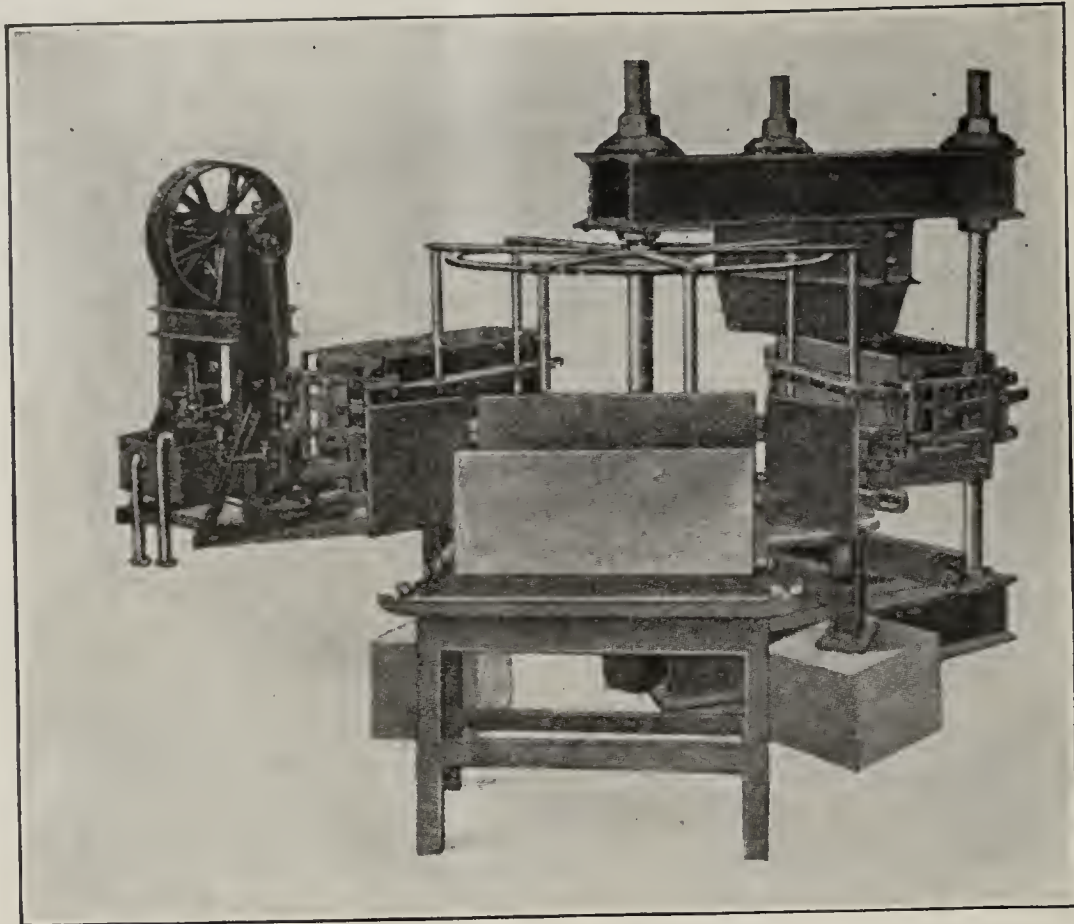
"Where the Reliable Reinforcing Steel Comes From"

Home Office: Chicago, U. S. A.

Detroit :: Minneapolis :: Indianapolis :: Des Moines



A DENSE CONCRETE



A Hydraulic Ram Pounding Concrete Into Blocks

TWO MEN do the work. From 1000 to 2000 blocks per day. Three quick-acting mold boxes rotating over the Ram on a Revolving Table, one being filled, one receiving the pounding, one delivering the finished block.

The Fisher Hydraulic Machine pounds a wet mixed mortar together with a Hydraulic Ram and produces a dense concrete with less than 5% absorption, with a high crushing strength, in any style to suit the demand.

Ask for Catalogue or any information regarding our system.

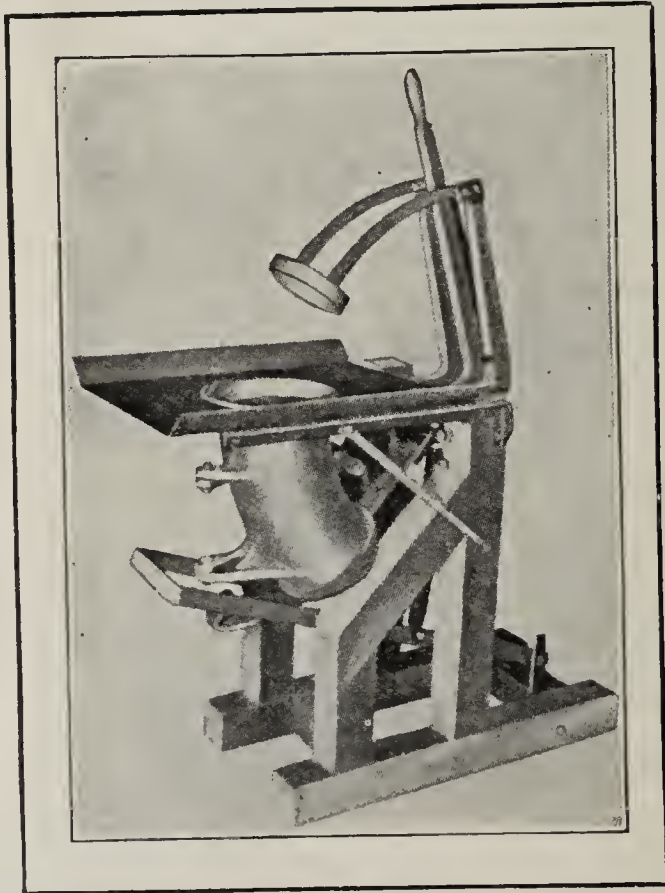
Fisher Hydraulic Stone & Machinery Co.

Builders' Exchange Building, Baltimore, Md.

Concrete Sewer Pipe Bends

The Only Machine
of Its Kind
on the Market.

Concrete Sewer Pipe
Bends Made on the
**RICKMAN SEWER PIPE
BEND MACHINE** Make
Money for the Manu-
facturer.



The Latest Thing
Added to the Concrete
Machinery Line.

ONE MAN can make from 15 to 20 curved sections of pipe per hour. Shovel in the material, tamp it with the tamping ring, operated by foot lever, attach the bell-end form, complete the section, withdraw core from below, by lever, carry the pipe away to a pallet and bring the outer mold back to the machine.

You Need This Machine to Complete the Equipment of Your Tile Factory

Write for Circulars and Prices

R. L. RICKMAN CO.,

987 Westminster Avenue,
VANCOUVER, B. C.

Why Don't You?

Make Your Own Cement in the manufacture of SILICATE BRICK and STONE out of Sand, Slag, Quarry-Waste, or any silicious material, with a small percentage of Lime.

Our "DIVISION-METHOD" will produce a higher grade product at a lower cost than can be made under any other process.

"RAW MATERIAL TO FINISHED PRODUCT—24 HOURS."

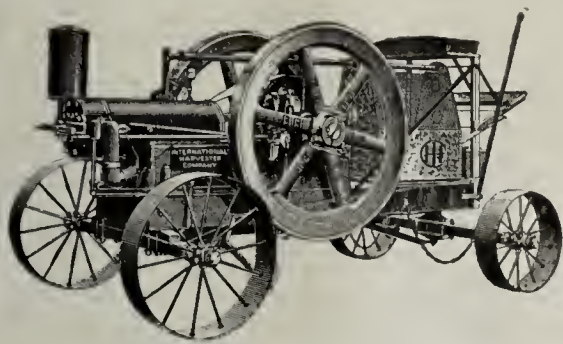
We furnish all Machinery, erect complete Factory and turn it over in perfect running order.

Write for full particulars to

International Sand-Lime Brick & Machinery Co.

90 WEST STREET, NEW YORK CITY

ENGINEERS AND CONTRACTORS FOR SILICATE BRICK AND STONE FACTORIES.



I H C GASOLINE ENGINES

Dependable under all Conditions

That is what the concrete worker needs—power he can rely on no matter what the conditions—an engine that will run and run right—winter and summer—in the wet and open as well as housed—that will give good service, anywhere, any time—that will stand up under long hard running or sudden emergency—in short, an I H C.

I H C gasoline engines have proved their reliability through years of hard service in all parts of the world.

Their simplicity and strength make them ideal for concrete mixing and other hard rough work.

And the same high grade construction that makes them most reliable makes them also most economical.

I H C gasoline engines give most power, on least fuel, with least trouble, and for longest service. They may be had in any size or style—vertical or horizontal—air or water cooled—stationary or portable (skids or trucks)—1 to 25 horse power. They offer just the engine you are looking for. Write us for catalogue and full information.

International Harvester Company of America,
(Incorporated)

41 Harvester Bldg

Chicago U S A



DU PONT



OFFICES

- BIRMINGHAM
- BOSTON
- BUFFALO
- CHICAGO
- CINCINNATI
- DENVER
- DULUTH
- HAZLETON
- HOUGHTON
- HUNTINGTON
- JOPLIN
- KANSAS CITY
- MEMPHIS
- MEXICO CITY
- NASHVILLE
- NEW ORLEANS
- NEW YORK
- PHILADELPHIA
- PITTSBURG, KAS.
- PITTSBURGH, PA.
- PORTLAND
- SALT LAKE CITY
- SAN FRANCISCO
- SCRANTON
- SEATTLE
- SHREVEPORT
- SPOKANE
- SPRINGFIELD
- ST. LOUIS
- TERRE HAUTE

DU PONT "A"

BLASTING POWDER

is recommended for
blasting dimension
stone. It is remark-
ably even and regu-
lar in its action.

1802
1910





E. I. DU PONT DE NEMOURS POWDER CO. Wilmington, Del. U.S.A.

COPYRIGHTED BY E. I. DU PONT DE NEMOURS POWDER COMPANY, 1910

CHARLES F. MCKENNA, Ph. D.

Inspection of Cement

and all other Engineering Materials. Examination of Properties and of Economical Operation of Works.

**Consulting and General Practice in
Chemistry, Technology, Chemical
Engineering and Chemico-
Legal Cases.**

Long Distance Telephone.

Cable Address: PLAT PEARL

Laboratories: 221 Pearl St., New York City

Offices: 50 Church Street

Hotel Cumberland

NEW YORK

S.W. Cor. Broadway and 54th St.

Near 50th Street Subway Station and 53d Street Elevated

**HEADQUARTERS FOR THE CEMENT
AND MACHINERY MEN.**

New Modern Fire Proof

All Outside Rooms. No Carpets. All Oriental Rugs.

Transient Rates \$2.50 with Bath and up.

10 minutes walk to 20 theatres.

Send for Booklet.

HARRY P. SIMPSON, Formerly with Hotel Imperial

R. J. BINGHAM, Formerly with Hotel Woodward

SELECTED WHITE SAND

For.

Ornamental
Concrete
Stone



For.

Hard
Plaster
Finishing

Cement
Block
Facing

Exterior
Plastering

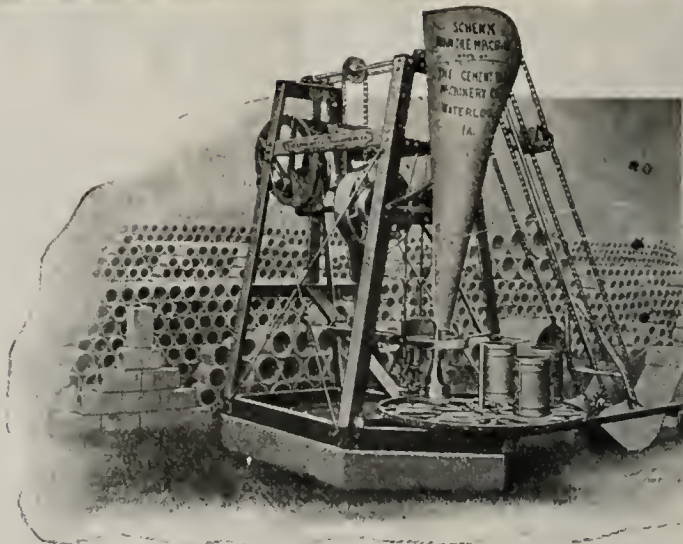
Stone & Marble Sawing

Shipped in paper lined box cars or 150 lb. bags

UNITED STATES SILICA CO.

1041 AMERICAN TRUST BLDG.

CHICAGO



The Schenk Cement Drain Tile Machine

is conceded by all who are familiar with the concrete machinery business to be absolutely the most perfect and the most successful machine in the field; upon its merits the cement drain tile industry has been built; and on account of its success other machines have been constructed, but no machine at the present date surpasses the Schenk Machine for capacity, durability, convenience, economical operation and for satisfaction.

We sell the Schenk on an Iron Clad Guarantee, backed by the largest exclusive concrete machinery manufacturers in the world.

Our free catalog, "Money in Cement Tile" will give you interesting information relative to the proper equipment, the construction of buildings the amount of capital required, the amount of profit to be expected; in fact, it tells how to start a plant for the manufacture of cement drain tile and just what you will be able to realize on your investment.

Write for it today.

The Cement Tile Machinery Co.
WATERLOO, IOWA

Face Your BlocksMake Them White

Do You
Use

WHITE SAND

Leading contractors specify our pure White, Washed and Screened Silica Sand for fine work in ornamental stone, block facing, porch work, ornamental lawn fixtures, vases, etc.
This sand is shipped both DRY and DAMP.
Prices and Samples on request.

BALLOU'S WHITE SAND COMPANY
MILLINGTON, ILLINOIS

**IT WILL PAY YOU
TO USE**

CROWN HYDRATE

(HIGH CALCIUM HYDRATED LIME)

For Waterproofing and Concrete

It Improves Its Strength and Color. Ask the

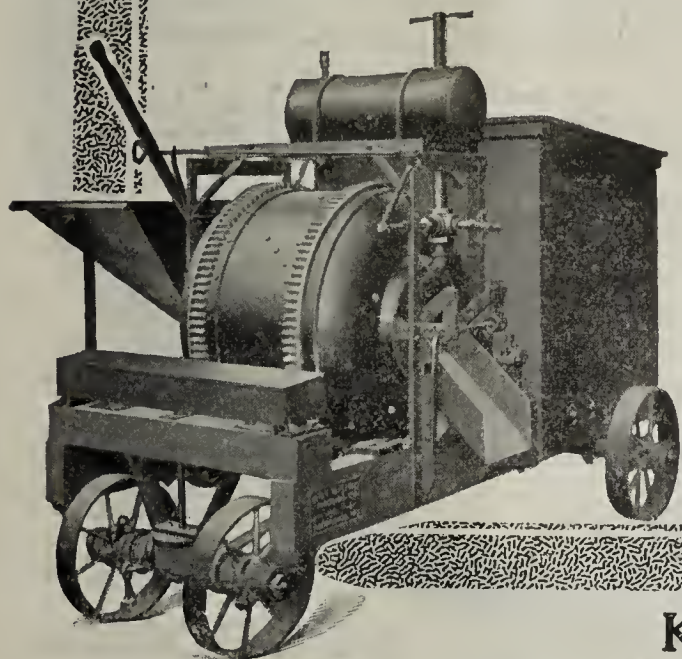
Marblehead Lime Company

KANSAS CITY

CHICAGO

By Any Standard of Quality The Koehring Concrete Mixer Is Peer

In Quality of Product
—Quantity of Output—
Manual Labor Saved
and Dependableness
of The Machine—
None Other Excels.



THREE independent mixings in the one drum, each performed by a positive mechanical force, with no sharp angles or corners is a guaranty of quality of mixing.

Lifting and pouring from the side, casting alternately from end-to-end, breaking over against heavy cast iron heads of the drum and a constant pouring off the inner end of the discharge chute represents a rapidity of mixing no other equals.

Discharging by merely raising the inner end of the discharge chute and always taking out the exact quantity desired, is manual labor economy you know is the minimum.

The heaviest constructed drum on any mixer, resting on trunnion rollers placed close to the ends, the rollers cast with wide faces, chilled as hard as tempered steel, and a double gear drive with pinions placed high to prevent binding in case the drum settles, comprises a dependableness the greatest mechanical genius will never question.

Built in types and sizes for every requirement; equipped with gasoline, steam or electric power.

It's chock full of dollar-saving quality—quality in the concrete and quality in the machine. Ask for "Catalog B."



KOEHRING MACHINE COMPANY

614-616 GERMANIA BUILDING

MILWAUKEE, WIS., U. S. A.



NONE JUST AS GOOD

THESE BOOKS are intended to be read by everyone who intends building. It makes no difference what you are going to build, you cannot afford to consider building without considering concrete as a building material. You cannot afford to consider concrete without knowing about

ATLAS PORTLAND CEMENT

BOOKS IN THE ATLAS CEMENT LIBRARY:

Concrete Construction about the Home and on the Farm	Free
Concrete Houses and Cottages, Vol. I—Large Houses	\$1.00
Vol. II—Small Houses	1.00
Concrete in Highway Construction	1.00
Reinforced Concrete in Factory Construction, delivery charge	.10
Concrete in Railroad Construction	1.00
Concrete Cottages	Free
Concrete Country Residences (out of print)	2.00
Concrete Garages	Free

Write for any or all of them to

The **ATLAS Portland CEMENT Co.**

Dept. D, 30 Broad Street, New York

Largest output of any cement company in the world.
Over 50,000 barrels per day.

NOT THE NOON HOUR



REPAIRS ON THE MAIN DRIVE.

Perhaps this has happened in *your* plant? The belt-ing gives out. Machinery stops. Hands idle. But expenses run right along. Such mishaps can be avoided and highest efficiency permanently assured by using

RELIANCE Guaranteed
Leather Belting
Repair Bills Reduced

For Tube, Ball, Griffin and Fuller Mills it is unsurpassable. Every Reliance Belt for cement work is protected by a special dressing.

Write for booklet.

Chicago Belting Company

12-22 Green St., Chicago

Branches: New Orleans, 431 Gravier St. New York, 71 Dey St.
Portland, Ore., 94 First St. Philadelphia, 234 N. Third St.



"Safest to use, because richest in Bitumen"

"Pioneer"

OUR asphaltic products were first introduced in 1896. For 14 years they have been undergoing the hard practical tests of every day use, and Engineers of repute in all parts of the United States are specifying "Pioneer" Asphalt materials today, because these materials have proven superior to all others.

Wherever there is a reservoir to be waterproofed specifications should be adopted which will prohibit the use of an inferior grade of asphalt. Wherever pipe line construction is in progress the question of *protection and preservation* of the pipe ought not to be decided upon mere claims, but the rigid demands of *specifications that are safe* should be enforced as a check upon lax methods and inferior materials.

"Pioneer" Reservoir Waterproofing Asphalt "Pioneer" Mineral Rubber Pipe Coating

Here are two commodities that will meet the demands of the specifications suggested. They are not experimental, but have both been used with the highest success for years, and under the severest conditions.

Over 99½% Pure

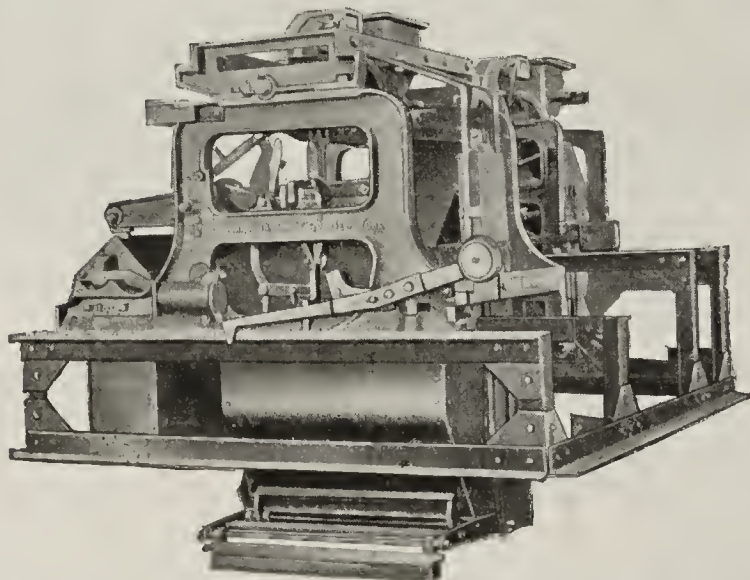
The superior quality of our asphalt is a *proved-out* proposition—a *known quantity*. Our own mines in Utah contain immense deposits of the purest hydro carbon known, our Gilsonite analyzing over 99½ per cent pure bitumen. In any true technical comparison of values "Pioneer" Mineral Rubber Pipe Coating and "Pioneer" Reservoir

Waterproofing Asphalt will readily demonstrate the superiority which has made them practically non-competitive. Send for our specifications and be safeguarded against those asphalt (which are offered as being equal to "Pioneer") the employment of which has, in spite of claims, proven them to be inefficient.

The American Asphaltum & Rubber Co.
600-614 Harvester Bldg.,
Chicago, Ill.

A
14
Year
Record
of Success

TO MAKE THE BEST CEMENT, USE Richardson's Automatic Proportioning Scales



Two or more scales yoked together with our Electric Discharge Mechanism will weigh Crushed Raw Materials direct from bins with perfect accuracy and discharge simultaneously.

These machines fitted with our Conveyor Feed will also weigh Pulverized Materials direct from bins.

Greatest Possible Range of Weights. Exact Proportions Absolutely Guaranteed. Continuous Uninterrupted Operation.

Similar Machines for Clinker and Gypsum. Automatic Hopper Scales for weighing Cement to Stock Bins. Automatic Bagging Scales for Finished Cement. Speedy and most accurate yet devised.

Write for particulars to

RICHARDSON SCALE COMPANY
16 Park Row, NEW YORK 122 Monroe St., CHICAGO

Highest Class Cement Rope Sacks

CEMENT SACKS FURNISHED PLAIN OR PRINTED

Samples and quotations
furnished upon request

CONTINENTAL PAPER BAG CO.

Paper Mill, Bag Factory and Printing Plant

RUMFORD, MAINE

Address inquiries to General Office,

**Whitehall Bldg., 17 Battery Place
NEW YORK CITY**

CEMENT

... AND ...

ENGINEERING NEWS



Reinforced Concrete Garage of Standard Automobile Company of Pittsburg Pa. The entire interior construction of this Building is of reinforced concrete, including floors, columns, stairways, etc.

See page 337.

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

WILLIAM SEAFERT, Editor and Publisher

 OFFICE—22 Fifth Avenue
 Cable Address -- "Seaferts" Chicago.

 Entered at the Post Office at Chicago, as Second-class matter, July 21, 1896
 under Act of March 3d, 1879.

 Subscription. \$2.00 Per Year
 Foreign Subscription. \$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON

Advertising Manager

Chicago, August, 1910.

THE WATERPROOFING PROPERTIES OF COLLOIDS.

Since we have learned to attribute the resistance of mortars to water to the action of colloidal bodies, the words "colloid" and "mineral glues" have been found to be handy terms, not only in explaining the hardening of cements, but likewise in presenting to the U. S. patent office methods of coating concrete or waterproofing it to some extent with solutions of colloidal substances or by admixing colloids to the cements in powdered form. Although all of these methods have been in use for years or even for half a century and in some instances even longer, the would-be inventors succeeded in persuading the U. S. patent office to grant patents simply by claiming that the action of their admixtures was due to colloids. The patent examiners were thus deceived by a novel way of explaining the hardening of cements and readily issued patents on methods of improving mortars which were in common use. Thus we have seen patents granted on admixtures of dried or baked clays or shales to cements, a method in vogue for several decades wherever the more reliable and efficient puzzuolanas, granulated blast furnace slag and natural puzzuolanas, that is to say volcanic lavas, could not be found.

In some instances these would-be inventors had no intention whatever to deceive the patent-office, but were merely blissfully ignorant of what was going on in the cement world. After hardly having digested the primers of the cement literature, they start out to make experiments of their own, guided by some vague practical knowledge of cements. They do not even take enough time to examine their "inventions" for a sufficient period, but feel entitled to make their experiments of a few months the subject of a paper to be read before an engineering society. Thus we witnessed during the past months the publication of a paper on the application of sodium silicate, water glass, to concrete, in which the author claimed to be confident to have solved all difficulties hitherto experienced in the way of waterproofing cements and of preserving Portland cement concrete in alkaline soil and in sea water. We shall see later on that this application of sodium silicate (which has been in vogue as long as Portland cement and water glass were known and which is described in all cement books covering the subject of coating and waterproofing cements) is one of the least reliable and least desirable methods. The subject would not be worthy of note, if this paper would not have been presented to the American Society For Testing Materials, an association which may be expected to examine more thoroughly similar papers offered to them for publication, so much more as a special committee on Waterproofing of this society

has come to the conclusion that concrete, if properly made, is waterproof and requires no admixtures, hence denies all claims made by dealers in waterproofing compounds. Another method of a similar unreliable nature, which has been patented recently, consists in transforming Portland cement into a jelly by stirring it with a large amount of water and in applying this gelatinous mass as a surface coating to concrete or in mixing it with concrete. Also this method has been used for a number of years prior to the time when a patent was applied for and is consequently free to every one. All similar patents, therefore, are void and can not be defended in court. In order to annul the patents it suffices to prove by the available literature that the so-called inventions are common practice or have been used on a large scale before the patent was granted, and this will be easy to do for all patents that are based upon admixtures of colloids, for all effective colloids that have to be considered have been used for a long time without ever having formed the subject of patents, and only the correct description of their action based upon modern researches formed the novel feature of the patent.

Although the above-mentioned Committee demonstrated that, in careful laboratory tests, concrete can be made waterproof also without admixtures of waterproofing compounds, it must be admitted that these conditions seldom prevail in practical operation and that waterproofing has frequently to be resorted to. This is especially true in sea water and sulphur and alkaline water, in which cases the waterproofing compounds prevent the progress of the decaying influence of the chemicals dissolved in the water.

The question next presenting itself is: Of what nature have waterproofing compounds to be in order to effectually fulfill their duty? Extensive experiments made to this effect by eminent French engineers demonstrate that all organic preparations, like stearic acid or stearates and similar compounds, of which there is a great number on the market, not only decrease the strength of the concrete, but utterly fail to retard the decomposing action of the salts contained in the water. Effective waterproofing and protecting of Portland cement in water containing corroding salts is only possible by the admixture of substances which are principally composed of the three colloids silica, alumina and iron oxide, the elements contained in cements besides calcium oxide. Such substances are termed puzzuolanas, artificial or natural, and are found in the form of volcanic lavas, or are obtained by granulating blast furnace slag or by drying or baking clays or shales. The lime or calcium hydrate, becoming free in the process of decomposition following the mixing of the calcareous hydraulic cements with water, acts upon these colloidal bodies (of which silica is the most effective and alumina the least desirable, with iron oxide taking an intermediary position) and swells them slightly in a similar way as rice grains swell in boiling water,

The opposite way, however, follow those who use solutions of these colloids, for instance sodium silicate or alum solutions, or Portland cement transformed into a jelly, and apply these as a coating or as an admixture to the mortar. All they obtain by these applications is a precipitate of voluminous flakes of colloids within the pores of the mortar, that ultimately decrease in volume and consequently invariably fail to waterproof the concrete for any length of time. Moreover, similar applications are highly unwelcome on account of the alkaline salts in combination with them, which cause unsightly efflorescence.

FUSED PORTLAND CEMENT.

By C. Unger.

Translated by Dr. W. Michaelis, Jr.

(Continued from Page 288.)

Fused Portland Cement Raw Mixtures: The following experiments on a large scale were made with raw materials used in the manufacture of Portland cement at a large cement plant. (At first only mixtures were used of a composition customary in the manufacture of cement and the percentage of lime was kept as low as possible. The contents of calcium oxide were then gradually increased up to the highest limit possible.)

The first lot of fused Portland cement had a smooth, glossy, dark-brown surface and, if broken, showed an exceedingly fine grain of a gold-yellow color. The iron was determined together with the alumina as R_2O_3 . In addition to this, it was estimated twice by titration, in the first place the total percentage of iron and afterwards the part present in the form of lower oxides. These two determinations of iron yielded in all fused products exactly the same results, thus giving proof of the fact that my fused Portland cement contained all of the iron in the form of the lower oxide, FeO . This observation was in contrast to Loebell's experiments with vitrified Portland cements, which showed that almost all iron was present in the form of ferric oxide, Fe_2O_3 .

Remark by the Translator: Unger's fused Portland cements, therefore, differed from commercial Portland cement considerably, because the iron oxide did not act as acid, as in vitrified Portland cement, but as base. In ordinary Portland cement, the iron oxide combines with calcium oxide and forms CaO, Fe_2O_3 or more likely $2CaO, Fe_2O_3$, that is to say calcium ferrites. In Unger's fused Portland cements, which evidently were molten too fast and in a reducing atmosphere, the iron combined with the silica and formed ferrous silicate, FeO, SiO_2 .

The composition of the fused Portland cement was the following:

SiO_2	26.10%
R_2O_3	12.30%
CaO	58.00%
MgO	3.34%

This fused cement hardened only very slowly and imperfectly, whereas parts of the same mixture which were burnt only to the point of vitrification hardened rapidly.

In accordance with the experience made by Michaelis with fused cements, the percentage of lime was now increased.

As soon as the amount of calcium oxide surpassed 60%, a change in the structure of the molten mass became noticeable. The exterior was the same, but broken pieces showed that gradually a core of a different color and sharp outlines was formed. This was due to the fact that the inside cooled more slowly and, therefore, remained in the fused state for a longer time. Upon further increase of the contents of lime, hollow spaces formed inside of the slowly cooling mass which were lined with comparatively large crystals visible with the naked eye. The quickly cooled outside, however, showed again, upon breaking; the former fine-grained structure of yellow color.

The chemical analysis of the outside and inside showed a marked difference. The crystalline core contained considerably more calcium oxide, while the percentage of silica was about the same in both cases. The assumption that the percentage of calcium oxide

had to be increased in order to obtain a higher amount of active constituents was fully verified, for the strength results to be reported later will show that the crystalline inside gave by far the better cement.

Analysis of the crystalline core:

SiO_2	23.61%	
R_2O_3	8.73%	CaO to SiO_2
CaO	66.22%	equal to
MgO	1.61%	3.02 to 1.

Analysis of the outside layer:

SiO_2	24.20%	
R_2O_3	12.94%	CaO to SiO_2
CaO	58.81%	equal to
MgO	3.34%	2.62 to 1.

Now the percentage of lime was further increased. At about 67% CaO the whole mass showed a crystalline structure and the hollow spaces lined with crystals had increased in number and size. The color of the crystals varied between yellowish-red and greenish.

The strength results obtained from the fused products increased in proportion to the percentage of lime, hence also with the growing amount of well-formed crystals which, therefore, must be considered as the really active part of Portland cement.

The maximum strength was ascertained at 67% CaO . The figures obtained were: 480 lbs. per sq. in. for the tensile strength of mortars consisting of 1 part cement and 3 parts of sand, and 5970 lbs. per sq. in. for the compression strength of the same mortars, both after 28 days.

Upon further increasing the percentage of lime to 70% CaO , again a change of structure took place resulting in crystal groups radiating from numerous centers. The color became lighter at the same time. The hollow spaces still existed; they contained only few crystals, but these were of large size, up to 3 mm. in length. The tests for soundness and other reactions plainly showed that from now on uncombined lime was present. The hardening cement began to blow, but showed this difference from ordinary blowing cement that the cement pats curved and were lifted off the glass plates. The broken pieces of fused cement of so high a percentage of lime fell into small pieces within a short time, although they were kept in closed vessels, while the former fused cements containing less lime remained unchanged for many months.

These results were found sufficient, as a further increase of the percentage of lime did not promise any additional information.

The most important point was now the examination of the crystals found in the cavities of the slowly cooling molten cement. As described in the first part of this paper, Le Chatelier was unable to analyze the crystals observed by him; he took a round-about way by applying the results of the investigation of the grappiers to his crystals. Toernebohm did likewise not achieve his object by his method of levigation and based the composition of the "alite" upon a very contestable calculation.

The difficulties encountered by both investigators were minimized by the present investigations in as much as the crystals obtained 3 mm. in length, whereas those of Toernebohm's preparations were only 0.1 mm. long. Besides, they are not only spread throughout the fused mass, but form large accumulations within the cavities, or druses.

For the examination of the crystals the hollow spaces containing the most perfect crystals were selected and

the crystals were broken off without any effort. These crystals could be identified with certainty as the "alite" of Toernebohm's experiments. Their appearance was the same, as the photographs published by Toernebohm revealed at a glance.

Microscopic examination proved that the fused cement was of a crystalline structure throughout without leaving an amorphous glassy residue; it was composed of two different substances, of an uncolored substance forming more or less regular hexagonal plates possessing slight double-refraction and of a yellowish-brown micro-crystalline and strongly double-refracting substance. The former combined with high light-refraction (higher than Canada balsam) low double-refraction and was even isotrope in many parts of the fusion.

Thus the investigation of these products was made easier than that of cements resulting from former researches, because my fused cements contained two well-defined constituents of characteristic properties in opposition to the five minerals described by Le Chatelier and Toernebohm. The colorless crystals were "alite." However, they differed from Toernebohm's alite in as much as he described it to belong to the rhombic system, whereas mine was hexagonal.

The yellow, strongly light-refracting substance in which the alite was imbedded could be recognized without difficulty as Toernebohm's celite. Other minerals were not present. But even these two minerals offered to some extent the same difficulties that Toernebohm met with; for celite was invariably found in close contact with alite and was discovered even in the fissures and rents of alite crystals. This, of course, made the separation difficult.

At first a number of analyses were made of crystals from fused cements originating from raw mixtures of different composition with the purpose of finding out, whether any simple rules could be discovered. The crystals could be easily dissolved in dilute hydrochloric acid without leaving a residue. Then the silica was precipitated, and made insoluble by evaporation with concentrated hydrochloric acid, and the analysis completed in the customary way.

The following analyses refer to crystals taken from the druses of the fused cement samples. They were slightly adulterated by celite:

1.	SiO ₂	24.15%	CaO to SiO ₂ equal to 2.99 to 1.
	R ₂ O ₃	7.65%	
	CaO	66.82%	
	MgO	1.63%	
2.	SiO ₂	23.61%	CaO to SiO ₂ equal to 3.05 to 1.
	R ₂ O ₃	8.70%	
	CaO	66.73%	
	MgO	1.01%	
3.	SiO ₂	23.50%	CaO to SiO ₂ equal to 3.09 to 1.
	FeO	2.28%	
	Al ₂ O ₃	3.83%	
	CaO	67.33%	
	MgO	2.34%	
4.	SiO ₂	23.61%	CaO to SiO ₂ equal to 2.87 to 1.
	FeO	2.92%	
	Al ₂ O ₃	9.80%	
	CaO	62.02%	
	MgO	2.11%	
5.	SiO ₂	23.36%	CaO to SiO ₂ equal to 3.09 to 1.
	FeO	2.36%	
	Al ₂ O ₃	3.73%	
	CaO	67.50%	
	MgO	2.55%	

6.	SiO ₂	20.83%	CaO to SiO ₂ equal to 3.38 to 1.
	R ₂ O ₃	10.20%	
	CaO	65.26%	
	MgO	3.54%	
7.	SiO ₂	19.80%	CaO to SiO ₂ equal to 3.57 to 1.
	R ₂ O ₃	10.00%	
	CaO	65.50%	
	MgO	4.38%	

Analyses 6 and 7 represent the composition of the total crystalline mass.

Analysis 1 to 5, giving the composition of crystals, show considerable deviations in all constituents. The molecular proportions CaO to SiO₂ are on an average 3 to 1. This suggests that the colorless crystals consist of the much looked-for "tri-calcium silicate." In this event, not only the iron, but also the total percentage of alumina would belong to the colored strongly light-refracting substance, to the celite. In order to investigate this question, the following experiment was made.

From a carefully prepared, that is to say fused and slowly cooled mixture a large perfectly transparent colorless crystal was picked out by means of a microscope. This crystal showed not a trace of celite adhering to it. The powdered specimen was then treated with caesium sulphate, whereupon it developed after several hours the characteristic cubes of caesium alum. This served to demonstrate beyond doubt that the alite was certainly not pure tri-calcium silicate.

On the other hand, the alumina could not be considered merely an adulteration, for the reaction with caesium sulphate was so plain that a large amount of alumina was sure to be present.

This belief was confirmed, when I succeeded in accomplishing a perfect separation of the alite from the celite. For this purpose, carefully selected crystals were broken up into smaller pieces, by subjecting them to slight pressure, and then stirred with methylene iodide mixed with increasing amounts of benzol until a small part settled at the bottom of the funnel. This latter was separated and proved to consist mainly of celite. The specific gravity of this heavier portion was 3.16. The lighter particles had a specific gravity of 3.14 and consisted of alite with only slight admixtures of celite, as could be proven by microscopic examination after careful removal of the methylene iodide with benzol.

The material, after having been carefully separated in this way, was analyzed and showed the following composition:

SiO ₂	24.13%
Al ₂ O ₃	8.55%
CaO	65.04%
MgO	1.90%

Only a slight trace of iron could be detected.

From this follows, that the alite contains the bulk of the alumina, if not all of it, while the celite contains all the iron. Thus it is not at all obvious that, in the manufacture of cement, iron oxide and alumina may be considered equivalent and be figured together, for, during fusion, a thorough separation between both elements takes place, whereby they strongly influence, in different directions, the properties of the components of which they become a part. The alite, containing the alumina, is the active element of Portland cement and is easily decomposed by water, whereas the celite, containing all of the iron, is hardly affected by the water and must consequently be regarded as ballast. The iron, however, becomes of some value in practice by reducing the point of beginning fusion or vitrification.

In this connection it must be stated that repeatedly cements have been produced, in which all of the alumina was replaced by iron and which hardened well, in distinction from celite. This substitution of iron for alumina is possible only, if the iron is contained in the cement as ferric oxide, Fe_2O_3 . The celite of my fused cements, however, contained all iron as ferrous oxide, FeO .

A comparison between the analyses of the purified material and the separated part, furthermore, reveals the fact that the former contains invariably considerably less magnesia. From this should be concluded that the magnesia is by no means equivalent to the lime, as it is able to take the latter's place only to a small extent.

The analysis given last, referring to the composition of alite has some similarity to the composition of alite as given by Toernebohm, namely:

SiO_2	19.48%
Al_2O_3	7.83%
CaO	67.60%
MgO	3.00%
Na_2O	0.90%
K_2O	1.19%

Yet, the result must not be considered a repetition of his experiments, as he arrived at these figures through a more or less arbitrary method of calculation, which has often been criticized, while, in the present case, the chemical analysis of the substance itself is given.

It the following an attempt shall be made to determine the approximate composition of celite by a simple calculation. A direct analysis of the heavy part separated by means of methylene iodide was not made, because there was not enough of it and because it was adulterated with alite.

The material, before separation of the small amount of celite adhering to the alite, had the following composition:

SiO_2	23.36%
Al_2O_3	3.73%
FeO	2.36%
CaO	67.50%
MgO	2.55%

If we assume the alite to contain all of the alumina, which is more than probable, to judge from foregoing experiments, we are able to calculate from the analysis of the purified alite, namely:

SiO_2	24.13%	CaO to SiO_2 equal to 2.70 to 1.
Al_2O_3	8.55%	
CaO	65.04%	
MgO	1.90%	

the amount x of the silica and the percentage y of the calcium oxide, which in the material, before separation, was contained as alite:

$$8.55 \text{ to } 24.13 \text{ equal to } 3.73 \text{ to } x \\ \text{or } x \text{ equal to } 10.52 \text{ SiO}_2.$$

In the same way we obtain:

$$65.04 \text{ to } 8.55 \text{ equal to } y \text{ to } 3.73 \\ y \text{ equal to } 28.40 \text{ CaO.}$$

These values deducted from the total silica and total calcium oxide of the material before separation yield the composition of the celite as follows:

SiO_2	12.84 parts	or SiO_2	23.7%	CaO to SiO_2 equal to 3.03 to 1.
CaO	39.10	"	CaO	72%
FeO	2.36	"	FeO	4.3%

54.30 parts

This, of course, is only a rough calculation, but serves to show that the celite possesses a somewhat similar composition to that of the alite, as far as the

ratio between calcium oxide and silica is concerned. The main difference between them is that one contains all the alumina, namely alite, and the other, celite, all of the iron in the form of ferrous oxide, FeO .

All these investigations prove with certainty that alite is not a tri-calcium silicate, as it was believed to be by a number of investigators, and that a tri-calcium silicate can not be discovered in Portland cement.

But, also the theories assuming uncombined calcium oxide to be present in Portland cement as a necessary constituent do not harmonize with these experiments, unless this free lime can be proven to be an isomorphous admixture of the alite crystals. The assumption, however, that so complex a compound, as alite would be in this event, would crystallize isomorphous with calcium oxide is rather bold. The absence of free lime in alite is, furthermore, made probable by the fact that phenolphthaleine in concentrated alcohol does not show the slightest discoloration in the persence of alite. To be short, a theory assuming free calcium oxide plainly leads to contradictions.

After thus having ascertained the composition of the alite crystals, the question of their constitution becomes of paramount importance. The molecular proportions lead about to the formula: $5\text{SiO}_2, \text{Al}_2\text{O}_3, 14\text{CaO}$. This formula would demand:

SiO_2	25.4%
Al_2O_3	8.6%
CaO	66.0%

The analysis of alite showed, after deduction of the magnesia:

SiO_2	24.7%
Al_2O_3	8.7%
CaO	66.6%

However, the above formula is not very likely to be the right; it seems more advisable to use the ratio CaO to SiO_2 equal to 3 to 1. Then we obtain the formula:

$$5 \text{ SiO}_2, \text{Al}_2\text{O}_3, 15\text{CaO} \text{ or better} \\ 5 (3\text{CaO}, \text{SiO}_2) + \text{Al}_2\text{O}_3$$

This formula gives a better idea of the composition of alite crystals. It demands:

SiO_2	24.2%
Al_2O_3	8.3%
CaO	67.5%

which must be considered to correspond fairly well with the analysis of the alite, especially as the magnesia has been dropped in the calculation.

All endeavors to offer further explanations for similar compounds lead to the greatest difficulties, because the study of the minerals occurring in nature shows that, as a general rule, formation of double salts or substitution by isomorphous compounds takes place, whenever an additional element is introduced.

For instance, the contemplation of the feldspars teaches that they form a series of isomorphous mixtures both from a physical and optical standpoint, beginning with pure potassium feldspar (orthoclase), with the calcium-sodium spars as intermediary members and pure calcium feldspar (anorthite) as last link of the chain. The various members of this series of feldspars are only frequently occurring mixtures which, for easy identification, have been given special names.

Similar complicated conditions may possibly exist also in the case of alite, and a definite explanation of all the various points to be observed during the study of this compound is, therefore, in my opinion, a mat-

ter of the far future. The following meditation will lead to experiments which, in time, will throw light upon the subject:

The approximate composition of alite is now known. It can, therefore, be prepared by synthesis and, in fact, I did prepare it and obtained, in the small electric furnace, a product that was crystallized throughout. Microscopic examination revealed again two different substances, of which one was fused; hence, the product was evidently not homogeneous. The white powder set well and resulted in hardened cement of high strength. The composition was:

SiO ₂	21.97%
Al ₂ O ₃	10.53%
CaO	66.40%
MgO	0.98%

A repetition of these synthetic experiments with pure materials but on a large scale, in the large electric furnace, would be advisable, because, as formerly mentioned, the products obtained in the small furnace cooled too rapidly and consequently did not develop large crystals. It is to be hoped that also in these experiments in the same way as in those with ordinary Portland cement raw mixtures, druses lined with large crystals will form, which can be subjected to a microscopic and analytical examination.

The repetition of these synthetic experiments on a large scale in varying proportions will soon show, whether these products approach well-defined stoichiometrical proportions or whether they represent a series of isomorphous mixtures, of which, in the latter event, the principal factors would have to be determined.

The various synthetic products would have to be examined with regard to their behavior towards water. If by these investigations reliable methods can be worked out for the determination of the water of combination and of the products formed in the course of the hardening process, the road leading towards the final explanation of the hardening of cements may be considered to have been reached.

As the result of the foregoing researches has to be considered the proof that, by fusing of the materials in a suitable furnace of large dimensions, crystals can be produced which can be separated and which, for this reason, are better adaptable for microscopical and chemical examination than any material so far obtained.

Furthermore, it has been demonstrated that the various theories, assuming the existence of a tri-calcium silicate in Portland cement, are erroneous, and that the presumption of the necessity of large amounts of free lime in Portland cement could not be verified by my tests. As the active constituent of Portland cement, which alone possesses hydraulic properties, I regard a highly basic aluminiferous calcium silicate, which decomposes in contact with water and hardens.

GAS PRODUCERS.

By Nisbet Latta.

The fuel bill of the United States approximates \$750,000,000 annually. It nearly doubles the value of the world's output of pig iron, and represents more than six times the silver and gold mined annually in the United States. It is more than the total expenditures made in a year by the United States Government, and is greater than the gross revenues of all the railroads and steamship lines combined upon the American continent. Of all natural resources, both from a commercial and economic consideration, it is the most important. Upon our fuel depends the development of our civilization, the existence of our commonwealth, and the maintenance of our commercial prestige.

The supply of our fuel is limited. The better grades are already fast disappearing, and the country is suddenly awakening to a realization that its most fundamental asset, under present methods of consumption and waste, must quickly become exhausted.

Fuel in the form of coal represents surplus; it represents the stored energy of thousands of years; it is the conserved heat of the primordial epochs before the Age of Man, before the inception of civilized life. The use of fire is the line of demarkation between the dominion of man and beast. It marks the birth of civilization. The amount of combustion and consequent fuel consumption reflects the degree of civilization.

The fact is, moreover, that methods of combustion have changed but little in the entire history of man, and to our shame it may be stated that more than half of the fuel mined today is absolutely wasted, and becomes a loss to society, without any industrial performance, by reason of the common ignorance of its possibilities, and the crudity and inefficiency of its use.

Nearly 30 years ago, Sir William Siemens, in a lecture, stated: "I am bold enough to go so far as to say that raw coal should not be used as fuel for any purpose, whatsoever, and that the first step towards the judicious and economic production of heat is the gas retort and gas producer, in which coal is converted entirely into gas, or into gas and coke, as is the case in the ordinary gas works."

Had England and the United States adopted this farseeing suggestion at the time of its utterance, it would be impossible to calculate the vast saving of their natural wealth which would have accrued.

The world today, however, is experiencing an awakening. The recent Congress for the conservation of our natural resources instituted by Mr. Roosevelt, and re-inaugurated by President Taft, the work of the various engineering societies, and the broad publicity given the subject by every economic organization, all tend to make it the most vital question before the engineering and industrial world today. The subject of the most economical use of the fuel for the generation of heat, and the most effective application of that heat, for the creation of any given work or performance, either directly or in the manufacture of power, is a subject with which every man must become acquainted, be he engineer, manufacturer, or operator, in connection with any line of industry, for there is practically no industrial operation which does not, at some point in its sequence, require the generation of heat or power—usually both.

The reason for the lack of interest, especially in the United States, in the economics of combustion, is

The Louisville Cement Company, is preparing to carry out its invasion of Mexico, which is said to have been the territory almost exclusively of Germans, the latter having hold of most of the concessions in that country. It has been found impossible to import cement there to compete with the foreigners and the Louisville company is now building a plant a short distance south of the city of Mexico, at Tula, Hidalgo. The skilled labor will be exclusively American.

doubtless due to the fact that until recently political and economic conditions have allowed us to manufacture with a relatively large margin of profit. Our vast natural resources, a rapidly growing country, a protective tariff, and many other conditions, have prevented the necessity for those rigid economies which have so long been necessary upon the European continent.

The burden of a larger population, however, of increased competition at home and abroad, greater cost of living, higher wage scale, and the law of diminishing returns—all these, taken in combination with the fact that the "cream" is being rapidly "skimmed" from our natural resources are making necessary a revolution in manufacturing methods, the analysis of each detail of cost, conservation of energy and labor materials, and reduction of waste to a minimum.

It is not the intention of this article to elaborate or to discuss diadactically the technique of combustion engineering but merely to treat the subject in a sketchy way, outlining with broad strokes certain of the elementary facts upon which it is based; permitting the reader to interpolate and read between the lines.

The success or rather the fundamental argument of gaseous combustion is premised upon five elements:

- A. Complete combustion.
- B. Combustion without over ventilation or air excess
- C. Prevention of temperature localization
- D. Temperature regulation
- E. Heat distribution
- F. Heat recuperation.

The fact that these features are functions of gaseous fuel alone is self evident, nor is this theoretical side of the argument without practical confirmation.

Taking a ton of coal to be the unit of our fuel wealth, What will we do with it? How best utilize it to extract the maximum of benefit with the minimum of effort?

For instance, assuming 80% of the power (other than locomotive) in the United States to be non-condensing, we may tentatively approximate the following figures.

Steam Power:

Yield from one ton of coal 500 horse power hours.

Producer Gas Plant:

(Producer efficiency 80%).

Yield from one ton of coal 2,000 horse power hours.

Of course the analogy of these figures in estimating the total possible saving on our national fuel bill, through conservation of the present waste of power, may be questioned as to the directness of their comparison.

Coming, however, right down to the figures reflected by modern practice, we get some idea of relative power conditions by the following table of efficiencies:

Thermal efficiency of triple expansion (pumping) engines, full load—15%.

Steam Turbine 13.5%.

Compound condensing engine 13.5%.

Compound engine non-condensing 8%.

Simple Corliss non-condensing 6.1%.

Gas engine (75% load factor) 25%.

Or again, the number of B. T. U. required in the original coal (Assuming B. & W. standard boilers) to produce 1 B. H. P. H. may be estimated as follows:

Triple expansion condensing 17,000 B. T. U.

Turbine condensing 19,000 B. T. U.

Turbine non-condensing 42,000 B. T. U.

Compound engine condensing 19,000 B. T. U.

Simple Corliss Non-condensing 42,000 B. T. U.

Gas Engine (approximately) 10,500 B. T. U.

These figures where referring to steam conditions represent the best practice obtained upon an exceedingly high grade of coal, but from an economic standpoint we must take into consideration that the principal cost of fuel is the cost of transportation, and the higher grade fuels in the United States are concentrated into an extremely limited area of territory. Moreover, the vast volume of our fuel reserves is constituted by low grade, bituminous and lignitic coals, which by reason of their high volatile content and certain intrinsic peculiarities, are extremely inefficient in combustion within any boiler hitherto designed. While on the other hand these fuels, by reason of their hydrocarbon elements, are admirably adapted to efficient use in connection with the internal combustion engine.

Not only is this the case as directly affecting the cost of fuel, but it must also be taken into consideration that the tendency of our coal mining operations has been to "take the cash and let the credit go" and already terrific inroads have been made upon our best fuels, such as those lying in the Connelsville section of Pennsylvania and the Pocahontas territory of the Virginias.

The high carbon fuel such as anthracite, the type best adapted for steam production, is already seriously diminished to such an extent, in fact, that there is now before Congress a bill which has received the approval of the Bureau of Naval affairs, suggesting the purchase of our entire remaining anthracite supply; to be held in escrow for the United States Navy, to which purpose this fuel is essentially well adapted.

Again, in the consideration of our fuel bill we have not estimated the infinitely higher waste occurring in railway locomotive and traction work. Also, from a standpoint of broader economic consideration, we have not considered the reduction in labor, in favor of gaseous power; in which later it may be noted that experience shows a reduction in the cost of said labor of operation, due to gas engine practice, in direct ratio to, and corresponding with, the fuel saving attained.

It should be further noted that the vast majority of our power consumption is created by the aggregation of small isolated plants (not less than 8-10ths would be a conservative estimate) and in these plants the waste of both fuel and labor is greatest; whereas in the case of the gas engine installation, the efficiency of the small plant is practically as great as that of the large plant, the results per unit of fuel consumption being very nearly the same for all sizes of installations.

Nor is the power situation alone, in reflecting the advantages of gaseous fuel. It is even more manifest in other industrial operations where the creation and application of heat is necessary; and there are but few, by the way, which are exempt from this necessity at some point of their cycle of manufacture.

Take the calcination of lime for instance. With the rotary kiln, in the calcination of lime-stone, a duty of 6 pounds of lime to a pound of coal is frequently attained—an increase of from 60 to 100 per cent over the average run of "direct firing" practice.

The firing of brick constitutes another example of the efficiency of gaseous combustion, and the application of heat derived therefrom. The old Scotch kiln or even the more modern Down Draft kiln requires from 800-1000 pounds of good coal per thousand brick manufactured, while the continuous kiln fired with producer gas now performs a service of 1000 brick for every 300-350 pounds of coal consumed. Not only does this represent a duty of one-third of the volume

of fuel but there are many other advantages, such as reduction of labor, and equalization in the quality of product, due to the ability to control temperatures; and other conditions of operation together with an even dissemination of heat throughout the entire contents of the kiln.

During the year 1907 the production of coke in the United States amounted to 40,779,564 tons, valued at \$111,539,126. Of this amount only about 15% was the product of by-product ovens about 85% being manufactured in ovens of the bee-hive type.

In other words about 34,652,629 tons of coke, representing the carbonizing of nearly 70,000,000 tons of coal, were carbonized in bee-hive ovens; and assuming this coal to contain on an average of 35% of volatile matter, we might say that the thermal equivalent of between 10 and 15 million tons of coal were absolutely wasted, and lost from our national resources. Nor does this approximation of our loss from a standpoint of heat producing fuel, represent the monetary loss to our country; for it may be fairly assumed that the by-products of a ton of coke are in reality more valuable than the coke itself, especially when these by-products or derivatives are properly refined or developed.

A glance at the following table reflecting the average production of a ton of coking coal may illustrate this fact:

Yield from one ton of coal	
Pounds of coke.....	1300 to 1320
Pounds of tar.....	9 to 11
Pounds of Ammonia sulphate.....	35 to 40
Cu. ft. coal gas.....	(Approx. value of 475
B. T. U. per cu. ft.) 10,000 gross, 5000 to 6000 net.	

The demand for sulphate of ammonia created by the constantly increasing exhaustion of our soil is yearly greater; for there is perhaps no other available element which more efficiently restores nitrogen and enriches the productive power of the land, than this substance.

The uses of the gas for both the generation of power and heat are manifold in their nature, comparing favorably with natural gas, having perhaps two-thirds of the heat value of the latter, while possessing a higher heat value in the explosive mixture.

There are today more than 1000 commercial products upon our market, which trace their genera to the coal tar family tree; and the possibility of derivatives from this wonderful hydrocarbon compound are as yet unlimited by science. It is said that, of this multitude of products, the majority are imported from abroad. Probably not over 3% are manufactured within the borders of the United States.

It is not the intent of this article to deal in detail with the subject of fuel economics, but merely to bring before the reader a few of the more cogent facts, from which he may deduce his own conclusions and between which he may interpolate his own conditions.

There is an ancient and excellent adage that "willful waste makes woeful want," and it does not require the foresight of a seer to forecast the results of our present wanton extravagance.

The time will come when the balance of our natural resources must be cast up, and it requires only a reasonable foresight and intelligence to anticipate this day of reckoning, by affecting those economies which not only constitute a public duty toward society and posterity but are dictated by ordinary discretion, as a primary condition of industry. The mandate of economic management is:—"Do it now!"

COMBUSTION IN CEMENT-BURNING.

By Byron E. Eldred.

Generally speaking, the practical study of combustion has been made mainly from the stand-point of the steam engineer. This narrow view-point has left open a large field for scientific research on the application of combustion in other arts, where the conditions of heat-utilization are widely different from those presented in the steam-generator. The great economic importance of the boiler and the ease of measuring its performance, together with the comparative uniformity of conditions in the steam-generator, is, probably, quite largely responsible for the practical neglect of the study of the use of fuels in other arts save only on the basis of their thermal value.

Yet these other arts show quite plainly that a thermal-value basis alone is not sufficient. For example, in burning lime, under ordinary conditions of firing, a cord of wood will do as much work as a ton of coal though the latter affords more than twice the number of heat-units. Similar results are evidenced in burning brick, in the roasting of certain ores, in reheating billets, and in many other arts where heat is to be applied over extended areas to fragmental masses of more or less refractory materials. In these arts much is to be gained by a careful study of the application of the heating-agent in the form of the long flame, and in the production of the heat in contact with, or in direct proximity to, the object to be heated. Of necessity, in boiler-practice, combustion cannot be maintained in actual contact with, or in close proximity to, the object to be heated.

Speaking in a general way, heat is imparted from burning bodies to things to be heated in two ways: directly, by radiation, and indirectly, by transfer of the sensible heat of hot gases by convection or contact; by conduction from the hot gases. Both ways are utilized in boiler-practice—directly, by the radiation from the flame and from furnace-walls, and indirectly, by the heating effect of currents of hot-flame gases. But because the thing to be heated, the water or its metal container, is always at a temperature which will extinguish flame, the heat is always generated elsewhere and conveyed to the boiler; it cannot be produced at the point where it is wanted. Again, the very wide and essential difference between the heating of water and the work performed by heat in other arts lies in the property of the liquid to distribute the heat evenly throughout its mass.

Different conditions prevail in other arts; but these conditions have not been well studied, and our practice is crude. As regards radiation, the old axiom that the power of a body to intercept heat is inversely proportional to the square of its distance from the source of the heat, is still worth consideration. The application of pre-generated heat to extended areas of fragmental, more or less refractory materials, in the same way as in the boiler-furnace, is wasteful and unsatisfactory. This is the reason for the preference of long-flame fuels for certain work, and the reason why gas-producers are run with shallow fuel-beds for soaking-pits and billet-reheating furnaces; the reason why lean gas is wastefully produced at a much greater expense than the richer gas from the more economically operated producers that supply the open hearth furnaces. The lean gas gives a different type of flame; a slower, longer flame suitable for the comparatively low, slow heating of solid masses over extended areas.

This cited case of wasteful heat-generation to se-

cure special application is a fair support of my statement that the study of the phenomena of applied combustion has been neglected. The fact has never been pointed out that the reason for this wasteful low-fire producer-operation is to secure later the flame-results of a lean gas carrying a large percentage of the neutral diluent gases, nitrogen and carbon dioxide, though, as respects the latter, it is perhaps hardly to be regarded as a purely neutral diluent. The gas-producer operator knows only this indirect way of securing a desirable end, while to any man of ordinary scientific knowledge, the mere suggestion of the end to be attained should suggest the better way of an economical manufacture of the producer-gas and the later use of waste gases in admixture with air to produce the desired type of flame: a way which is susceptible of regulation and control.

In my studies of long-flame combustion, I have noted remarkably wide differences, and great advantages, in the application of the heating-agent to generate heat in contact with the work, as contrasted with the prior methods of applying pre-generated heat. The practical workings of this idea were investigated by a committee of the Franklin Institute about five years ago and reported on favorably; therefore, I will not go into further detail, and only offer the foregoing as a preface to the statement that I consider cement-burning as conducted in present-day accepted American practice a good demonstration of the crudeness of our application of the principles of combustion; and, to go a step further, of our lack of observation of the phenomena of combustion.

In the present practice of burning cement, the clinker is made by slowly passing a stream of finely-powdered cement materials through a rotary kiln of from 5 to 8 feet internal diameter and from 60 to 150 feet long. In the entrance of the kiln burns an aerially-supported flame-plume, generally axially directed, produced by powdered coal injected by air. In passing through the kiln, the materials, which are an artificial or a natural mixture of clay and calcium carbonate, are first dehydrated by the heat of the flame-gases. Then the carbonate is causticized by dissociation, or calcined, the carbon dioxide being driven off by heat, and finally the clay and lime unite to form the clinker.

Each of these operations, dehydration, calcining, and clinkering, has different thermal requirements, and yet in the ordinary practice all three are performed by one flame; a flame particularly adapted to the needs of the clinkering-operation and to that only. Clinkering requires a high temperature—a temperature sufficient to sinter the clay component and cause it to unite with the lime; but no great absorption of heat occurs; the action is exothermic. And as the calcines pass slowly under the blazing, heat-radiating coal-flame, they rapidly acquire the necessary temperature, and clinker. For the calcining, the waste heat of the flame-gases is considered all that is necessary; yet the marked economy of the slow-burning, voluminous flame for calcining is well known in other arts.

The net result is that the ordinary cement-kiln is a good clinkerer, a highly inefficient calciner, (the calcines often come into the clinkering-zone with a material percentage of their carbon dioxide remaining), and a very wasteful thermal device.

So far as combustion is concerned, the kiln is a horizontal flue, and, as in every other horizontal flue, whatever gas-stratification can occur will occur. Much does occur. The flame is purposely spaced away from the work in the clinkering-zone, and the gases

from it rise into the arch of the kiln and never get into effectual contact with the work in the calcining-zone. The heating in the calcining-zone is largely by radiation from the upper walls, and by direct conduction as the upper wall becomes the lower and moves under the onflowing stream of material. There is practically no direct heating by the flame-gases. These gases flow along the upper part of the kiln, and under them flows an entrained current of relatively colder air, partly brought in by the stack-suction and partly by the injector-action of the flame and coal-feeder.

Not only is the heating of the calcining mass inefficient, but the calcination is furthermore performed under the worst possible conditions. Calcination is a heat-absorbing reaction, and the evolved carbon dioxide is, therefore, relatively cold and dense, while it is naturally a gas of high specific gravity. It, therefore, tends to remain in the bottom of the kiln, flowing along as a separate stratum bathing the material, and very little admixed with the gases and air above. In other words, the carbonate is being calcined in an atmosphere of carbon dioxide; or, at least, an atmosphere which is abnormally rich in carbon dioxide. Now calcination is one of the reactions which, like evaporation, depends very much upon the ambient atmosphere. Other things being equal, and within certain ranges of temperature, the heat required to dissociate calcium carbonate is inversely as the percentage of carbon dioxide in the atmosphere. That is one of the reasons why the rotary kiln is so poor a calciner as compared with the vertical, separately-fired lime-kiln. In the latter, the pieces of dissociating limestone are always bathed in a constantly changing atmosphere, which can never contain more than 21 volume per cent of carbon dioxide (the theoretical maximum for products of combustion), and which, as a matter of fact, never runs anywhere near as high as that amount.

In the vertical kiln, calcination and heat-utilization are very much better than in the rotary kiln, which is essentially a device adapted for the use of cheap fuel and expensive labor. And calcination, though not generally so recognized, is one of the most important functions of the cement-kiln. In the ordinary rotary kiln, the material comes into the vicinity of the clinkering-flame but partly calcined, and there is a sudden evolution of carbon dioxide at this point, disturbing the normal and orderly sequence of the operations and leading to the formation of clinker-rings and nodules.

As a labor-saving device the American coal-fired rotary cement-kiln was a great advance in the art over anything ever known before; but from the viewpoint of the heat engineer it is a grossly wasteful and inefficient apparatus. Though, theoretically, 25 pounds of coal should suffice for making a barrel of cement, the actual consumption is from 90 to 110 pounds. Many attempts have been made to lessen this waste of fuel; but they have not embodied a scientific application of fundamental principles and, hence, have not been successful. Regenerators, recuperators, and the like cannot be employed with the present single kiln, for the reason, among others, that the dust evolved in calcining is carried forward by the violent rush of gases through the kiln and would soon choke up such heat-recovering devices, and also because of the necessity for unimpeded draft under the conditions of high localized heat-generation with the burning of fuel, taking into account the large air-excess requirements and the increase in volume of gases due to calcination-products.

Succinctly, in the ordinary kiln two wholly-unlike operations, clinkering and calcining, are performed by one flame; and the results, so far as calcination is concerned, are not good, while the heat-waste is enormous. It is obviously better to perform the two stages as two stages in two kilns, and use for each combustion-methods best adapted for that particular stage. In doing this, moreover, the possibility of using heat-recovering devices is afforded, since, as it so happens, the dusting is mostly obviated by slow-traveling flames in both steps, while the high-temperature gases from the clinkering-operation can be used in regenerating the fuel for clinkering, and the lower-temperature gases from calcining can be used in regenerating for that operation, if desired, although this is less practicable. With the possibility of using regenerators comes the opportunity to use producer-gas, which, normally, gives rather too low a temperature for clinkering, in place of the more expensive powdered coal.

With this severing of the calcining from dependence upon the clinkering comes the practicability of a scientific utilization of combustion in the calcining-operation. The latter becomes a simple, lime-burning step, differing only in that the material, being finely powdered, cannot be handled in a vertical kiln and thus brought into actual contact with the flame and hot gases from ordinary firing-means. Something more than the ordinary type of boiler-furnace firing-means is necessary with fine material traveling down the rotary kiln. There must be a different type of flame: a flame filling the cylinder, and coming into actual contact with the material to be heated and there burning, in place of traveling along its top. It is, of course, possible to produce combustion in contact with material which, unlike water-cooled boiler-tubes, can be raised over a red heat; and in so doing, the law of the square of the distance is no longer so important. As a matter of fact, combustion is actually much more vigorous in contact with suitable refractory materials, such as lime, than elsewhere; a fact which will be apparent to any one who has seen the flames licking the furnace-walls. Recent scientific work has shown that this "wall action" much heightens the velocity of combustion and, concomitantly, the number of heat-units which can be evolved in a time-unit.

There are long-flame fuels; but few of them can be economically used in calcining cement materials, and fewer still will afford a flame capable of filling the barrel of the kiln. The flame of ordinarily good producer-gas is too short and scanty; and if it be burnt with regenerated air, as heat-economy dictates, it becomes still shorter. But the fat, long flame can be secured by the use of expedients which, looked at in one way, may be regarded as a development of the crude scheme of running the producer with an uneconomical "low fire." It is merely necessary to dilute the gas with a neutral gas, or, which is simpler, to dilute the air used for combustion. Or a triple mixture of air, diluent gas, and combustible gas may be made. Let us consider this last as the simplest case. If a mixture of combustible gas and air in theoretical proportions be made, ignition, of course, results in an explosion; that is, in a practically instantaneous combustion. When one portion of the gases is brought above a red heat, combination takes place and heat enough to carry on the reaction is evolved simultaneously. Now let us progressively dilute the mixture with an inert gas, say nitrogen. As the dilution goes on, the mixture becomes less and less explosive, till finally a point is reached where the ignition will no longer

propagate itself through the mass at ordinary temperature. A spark or a flame brings the mixture in its immediate vicinity to red heat and induces a local combination; but the ignition does not propagate through the gas mass. It will not burn. Now let us raise the temperature of the gas mass. Obviously it will again burn, and in burning the gas will evolve heat. In other words, if we pass the mixture through a kiln containing red-hot or white-hot lime, it will then burn and evolve heat. But, under the laws of "wall action," the burning will be the most intense where the gas is in actual contact with the hot solids.

With the above in mind, it is evident that we have it in our power to dilate the flame: to cause it to be as long and as voluminous as we please. All we have to do is to dilute our gas with stack-gases, or to dilute the air for combustion. Stack-gases are better for this purpose than pure nitrogen, even were the latter available, for the reason that the contained carbon dioxide, for chemical reasons, has a combustion-retarding action much greater than that of nitrogen, so that our gas-mass need not be so voluminous. If we dilute our air, we can burn oil or solid fuel, if we like, instead of producer-gas.

Presuming that we are burning producer-gas with air diluted with stack-gases, then, by a simple adjustment of the air-valve and of the stack-gas valve, we can make our flame lengthen and spread out till it fills the kiln. It does not burn at once and give gases rising into the arch; it burns all through the kiln, and it burns most rapidly at the point where it comes into contact with the powdered refractory material of the cement mix. In other words, we are developing a large part of our heat where we want it, in place of developing it all somewhere else and then transferring it to where we want it. And in place of calcining the limestone in an atmosphere of nearly pure carbon dioxide, we are calcining it in an atmosphere of flame-gases, an atmosphere which cannot contain so great a proportion of that gas.

By the separation of the calcining and clinkering steps, we can employ a slow-traveling draft-current through the calcining-kiln, because it is not necessary to expel the products of combustion from a zone of intense heat to make room for fresh fuel. The calcination may be accomplished without regard to the clinkering-zone conditions, and regulation should secure a low temperature of chimney-gases, which, under present practice conditions, carry off approximately six times the heat of the discharged clinker; and practically half of the heat waste accounted for in the chimney-gases is carried by the excess air required to support the combustion of powdered fuel. Prof. Joseph W. Richards' reported a test of a rotary kiln showing his calculation of a heat-balance accounting for 72.1 per cent of the total heat as lost in the chimney-gases.

The heat required for the combination of the clinker is variously estimated, but from 15 to 18 per cent. of the heat developed by the coal seems a fair proportion. Therefore, the clinkering-operation conducted in separate kiln should require but little fuel and much less attention, as good clinker depends most largely on properly-calcined material.

What I propose for the calcination is the present rotary kiln, gas fired with long-flame combustion. Such a kiln with such a gas-flame has produced more than 6 pounds of lime per pound of coal burned in a producer with low fuel-bed. "Good" gas-fuel reduced the output of the kiln materially. Next, I propose to take fritted calcines from the calcining-kilns to a special clinkering-kiln, which shall embody heat-

regenerators and gas-firing. Open-hearth practice gives us an idea of this operation.

This plan has not yet been put into commercial operation. German scientists have thought well of it, and it was expected that a demonstration would take place near Berlin this spring, but from last reports little progress, except on paper, has thus far been made. We can, therefore, only consider theoretically this proposition of cement-burning in a two-kiln operation.

Let us assume the production of a theoretical cement of the following composition, on which heat-determinations will be calculated:

	Per Cent.
Lime, corresponding with $(\text{Ca}_3\text{SiO}_5)$ and 1 $(\text{Ca}_2\text{Al}_2\text{O}_5)$	68.55
Silica	20.10
Alumina	11.35

All of the other constituents found in commercial cement are accidental impurities.

To produce the cement, the ingredients will be used in the following proportions:

	Kg.
Limestone (CaCO_3)	122.32
Clay $(\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 \cdot 2\text{H}_2\text{O})$,	28.75
Sand	6.7

Total weight of mixture..... 157.77

This amount of raw materials is required to produce 100 kg. of cement.

First, the mix must be heated to 900°C . to dehydrate the clay and decompose the limestone.

The heat-requirements for producing calcines are as follows:

For dehydrating the clay, there will be required 1,218 calories per kilogram of water dissociated from the clay. $2\text{H}_2\text{O}=4.01$ kilograms.

For dissociating CO_2 from limestone 1,026 calories per kilogram of CO_2 are required. It will be assumed that the specific heat of the mix is about 0.25.

$157.77-4.01=153.76 \times 0.25 \times 900,$ = 34,596 calories for heating.

$4.01 \times 1,218,$ = 4,882 calories for dehydrating clay.

$122.32 \text{ kg. of } \text{CaCO}_3=53.76$
 $\text{kg. } \text{CO}_2 \times 1,026$ = 55,157 calories for dissociating limestone.

94,635 calories for producing calcines.

For sintering, the heat-requirements are very much less; in fact, the exothermic reactions produce one-third of the heat required for heating the calcines to the sintering-temperature. The heat of combination of lime with silica and alumina in cement does not seem to have been accurately determined, but Le Chatelier found that in the combination of 3CaO , Al_2O_3 , 3SiO_2 , 150 calories were developed per unit of $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$, and as the silica and alumina exist in about that ratio in the cement, their sum multiplied by 150 calories will give the heat produced.

Clinkering.—For clinkering, estimating that the calcines are discharged directly from the primary kiln into the clinkering-kiln at 900°C ., and are therein heated to $1,300^\circ\text{C}$., a range of 400° rise in temperature, and assuming the specific heat of the calcines to be 0.30, $100 \times 0.3 \times 400=12,000$ calories are necessary. Therefore,

$100 \times 0.3 \times 400 (1,300-900)=12,000$ calories absorbed by clinker.

$31.45 (\text{SiO}_2 + \text{Al}_2\text{O}_3) \times 150=4,717$ calories produced.

7,283 calories absorbed from fuel.

This represents slightly less than 1 per cent. of fuel for clinkering.

The total heat-units in the clinker as discharged would be:

$100 \times 0.3 \times 1,300=39,000$ calories.

The above calculation represents the heat-requirement, provided that the combustion-gases left the kilns cold, and that the carbon dioxide gas from the limestone left the kiln at the temperature of dissociation.

Calcining.—Practical working-tests with a gas-fired rotary kiln, 100 ft. long by 6 ft. in diameter, burning limestone crushed to 0.5 in. size, such limestone containing 98 per cent of CaCO_3 , have shown that it is safe to assume an output of 6 parts of lime to 1 part of good gas-coal; therefore 68.55 kg. of lime would require 11.43 kg. of fuel, and as there are 68.55 kg. of lime in 100 kg. of cement, 11.43 kg. of coal would calcine all of the lime to produce 100 kg. of cement. There remains only the heat-requirement for bringing 31.45 kg. of $\text{SiO}_2 + \text{Al}_2\text{O}_3$ to the temperature at which the lime is formed. $\text{SiO}_2 + \text{Al}_2\text{O}_3=31.45 \text{ kg.} \times 0.25 \times 900=7,076$ calories, which would be equivalent to not more than 1 kg. of coal per 100 kg. of calcines; therefore, an estimate of work in the calcining-kiln would be:

11.43 kg. of coal for heat to produce 68.55 kg. of lime.

1 kg. of coal for heat to raise temperature of clay.

0.5 kg. of coal allowance for heat-losses in heating up clay.

12.93 kg. of coal per 100 kg. of calcines, or 1 of coal to 7 of calcines.

Assuming 180 tons to be clinkered per day in one clinkering-kiln, 180 tons = 180,000 kg. divided by 100 = 1,800 kg., or 1 per cent. There remain 39,000 calories in the discharged clinker, and assuming that one-third of this heat can be taken up by air-currents and supplied to the primary or calcining-kiln, 13,000 calories would be afforded, equivalent to 1.5 kg. of coal pr 100 kg. of calcines, which, subtracted from 12.93 kg. of coal used in calcining, gives 11.43 kg., or 11.43 per cent. of fuel, or 1 of coal to 8.75 of calcines.

Assuming an efficiency of only 25 per cent in the clinkering-kiln, or 4 kg. of fuel per 100 kg. of calcines, $1,800 \text{ kg.} \times 4=7,200$ kg. This would add 4 per cent to the fuel-consumption, or 1 kg. per 100 to the 11.43 required for calcining = 15.43 kg. per 100, or 15.43 per cent = 1 of coal to 6.48 of cement.

A regenerative system such as is shown by this plan is capable of utilizing for clinkering 84.2 per cent of the total heat of the gas produced, and the producer should have an efficiency of 80 per cent, thus giving 67.36 per cent efficiency for the combination of the producer and kiln, not allowing for loss by radiation. I believe it would be safe to assume 50 per cent efficiency for the clinkering-kiln outfit, allowing 17.36 per cent for loss by radiation. If this result should be realized, the process would yield 7.44 kg. of cement for each kilogram of coal consumed, based on practical working-tests with the gas-fired rotary kiln burning limestone crushed to pass a 0.5-in. ring.

CONCRETE IN AUTOMOBILE GARAGES.

Concrete construction seems to be peculiarly associated with the automobile industry in all its branches. The number of automobile factories which have been built of concrete of recent years is probably greater in proportion to the total number than in any other industry. The adaptability of concrete for pavements and speedways suggests a further application, and in the construction of both private and commercial garages it is being used extensively.

is applied either on wood or metal lath attached to a wood frame or on metal lath attached to a frame of steel tubing or light structural steel. When the stucco is applied either to wood lath or metal lath on a wooden frame, the building can scarcely be regarded as fireproof, nor is it as permanent as the latter form of construction, its only advantage being its lower first cost. Stucco is also used to a considerable extent in combination with other forms of concrete construction. It is occasionally applied on metal lath attached to a reinforced concrete skeleton. A good



Reinforced Concrete Skeleton
Garage of Edward R. Taylor, Penn Yan, N. Y.

It seems but natural that automobile owners having an investment usually of several thousand dollars in their machines should endeavor to give them the best protection from the elements, yet it is often the case that the owner of a two thousand dollar automobile will house it in a shed which offers practically no protection while another will spend a couple of thousand dollars in erecting a barn for a favorite horse worth only a fraction of the value of a good machine.

In considering the various materials available for the construction of a garage, concrete is sure to suggest itself. It is adaptable to any form of architectural treatment and with its unlimited possibilities for surface finish and ornamentation it may be made to conform to practically any design. In its various forms

metal lath for stucco work is made by Garry Iron & Steel Co., of Niles, Ohio. An example of this type is shown in the illustration of Mr. Edward R. Taylor's garage. In this case the expanded metal lath was attached to a reinforced concrete frame, and cement plaster applied forming stucco walls. The roof girders of this building are also of concrete, reinforced with old steel boiler tubes which were flattened and filled with cement mortar to protect them from corrosion.

Stucco may also be applied on concrete blocks or tile, giving to the building a very attractive surface finish, while the blocks or tile furnish a substantial backing for the walls. The garage of Harvey B. Smith at Lake Harriet near Minneapolis is of this type. This building is more than a garage; it might well be called



Group of Three Cement Stucco Garages, Oak Park, Ill.

it offers a variety wider than all the other materials which may be considered. Cement brick, concrete blocks, concrete structural tile, stucco and reinforced concrete are all available. Any of these forms may be used alone to good advantage and in combination they offer endless possibilities.

Of these various forms, stucco is undoubtedly the most popular for garages. Stucco as generally used

a convertible cottage. It was originally designed for a garage and has a basement, ground floor and attic. The walls are of stucco applied on concrete blocks, while the porch, presenting the same exterior appearance, is of temporary construction, being of stucco on wooden lath. The building is being used temporarily as a bungalow, pending the construction of a residence on the other end of the lot, when the porch will be

torn away and the building utilized as a garage. The architect for this building was Mr. Jas. Stone, Jr., of Minneapolis. N. H. Leighton Co., also of Minneapolis, were the general contractors and the cement work was done by Nelson Brothers Paving and Construction Co., of Minneapolis.

A very attractive garage built of reinforced concrete

of medium size. It is 33x100 feet in size and consists of a basement and ground floor. It is of concrete construction throughout. The side and rear walls are of plain-faced concrete blocks, the front being built of cement brick and the floors of reinforced concrete. It cost approximately \$5,000. It was designed and built by the Permanent Concrete Construction Co., of



Concrete Bungalow of Harvey B. Smith, Lake Harriet Minn.
(To be converted into garage)

throughout is that of Mr. Fred Pabst on his stock farm near Oconomowoc, Wis. This building contains several living rooms at one end which are used in this instance as the gardener's quarters, but practically the same design could be used for a combination garage and chauffeur's cottage. This was designed by Fernekes & Cramer, of Milwaukee, and built by the Newton Engineering Co., of the same city.

Concrete is equally adaptable for public garages. For a building which is to be used for storing automobiles worth, in the aggregate, hundreds of thousands of dollars, any but fireproof construction is out of the question. Even if no gasoline or other highly

Pierre, the reinforced concrete floors being designed by C. A. P. Turner, of Minneapolis, Minn.

Another large public garage is that of the Standard Automobile Co., of Pittsburg, two views of which are shown. The entire interior construction of this building is of reinforced concrete, including floors, columns, stairways, etc. Albert Kahn and Ernest Wilby of Detroit, Mich., were the architects for this building and D. T. Riffle of Pittsburg was the general contractor. Universal Portland Cement was used exclusively on all the above mentioned buildings.

In the newer residence districts of all large cities, a very large percentage of the garages are of concrete,



Cement Stucco Garage of E. H. Ehrman, Oak Park, Ill.

inflammable materials were kept in garages, the fire risk on the machines would still justify taking every precaution against fire, and with conditions as they are, it is almost incredible that so many owners of public garages should persist in building flimsy, wooden structures.

The building of the Wegner Automobile Co., of Pierre, S. D., is a good example of a public garage

the stucco type referred to above, being by far the most popular. In one single block in Oak Park, a suburb of Chicago, there are not less than eight garages of this type. Another group of three within fifty feet of one another is shown below. Even in localities where concrete does not predominate, it will be found that it is used almost exclusively for foundations and floors and in cases where a separate shelter is built for

the storage of gasoline either in a well or above ground, the steel tank can be best protected with concrete. Concrete floors can readily be designed to carry a turntable in the center, and they may easily be graded so as to afford perfect drainage. The number of all-concrete garages that are being built is constantly increasing, even at a greater rate than other classes of concrete buildings, the principal reason being that the average automobile owner appreciates the advantages of concrete, and not only has the desire to secure the best but also possess the means.

OKLAHOMA CEMENT SHOW.

The Oklahoma Cement Users' Association will hold their annual convention in Oklahoma City, October 6, 7 and 8th, during the Oklahoma State Fair.

The Third Annual Cement Show will also be held during the entire 13 days of the state fair, Sept. 29 to Oct. 9th, 1910, in the Cement Industries Building, which is now being constructed by the State Fair Association.

pany will establish a plant on a site secured on the M. K. & T. Railway, and hope to begin operations there within a few months.

L. K. Sharpe of Vicksburg, Miss., is owner of the project.

EMPTY CEMENT SACKS.

The Universal Portland Cement Company states that during March and April some 3,000,000 more cloth sacks were shipped cement-filled than were returned by the buyers. As each sack is charged to the customer at 10 cents, debited on the return of the sack, there is thus the tidy sum of \$300,000 scattered over the country in the form of empty sacks in old sheds and forgotten places. This is very good for the sack makers but obliges the manufacturers to maintain a very large stock of sacks on hand. It also emphasizes the old saw as a variant of which, would be that expressed thus: that if you take care of the sacks the dollars will take care of themselves.



Reinforced Concrete Garage and Gardener's Quarters
Pabst Stock Farm, Oconomowoc, Wis.

Parties desiring space for exhibits should write E. A. Mossman, Assistant Secretary, at once.

A large concrete block plant, equipped with modern handling machinery so as to reduce labor cost as much as possible, has been designed for the organization founded by Mrs. Russell Sage in order to provide modern homes for workingmen at a moderate cost. The tract purchased for these homes is in Forest Hills, Borough of Queens, New York City, and the block plant is to be located on the property. The plans have been drawn by Mr. Grosvenor Atterbury, architect, New York.

The Luverne Concrete Co., Luverne, Minn., has been incorporated by L. E. Coss, Dr. C. L. Sherman, C. J. Martin, H. E. Cornish, H. E. Peterson and E. R. Coss. H. E. Cornish is manager.

The Humboldt Cement Products Mfg. Co., Humboldt, Iowa, is erecting a cement block plant.

With a capital of \$25,000, the L. K. Sharpe Concrete Telegraph, Telephone and Railway Pole Company was organized in Oklahoma City. The new com-

CONCRETE PRODUCTS MANUFACTURERS.

The plant of the Milbank Cement Construction Co., Milbank, S. D., is nearing completion. The construction is of cement blocks, with cement roof, and will have a daily capacity of 12,000 brick and 500 to 600 building blocks.

A. W. Hollingsworth, T. W. Denney, I. B. Musgrove, J. R. Busby, H. D. Jarvis and others, have incorporated the Rose Hill Tile Co., of Rose Hill, Iowa, with a capital of \$10,000, to manufacture drain tile, brick, etc.

F. W. Kutach has established a plant at Hallettsville, Texas, to manufacture concrete blocks.

S. A. Stone proposes erection of concrete product plant at Chillicothe, Mo.

C. W. Requarth, Lancaster, S. C., will manufacture concrete sewer and drain tile, etc. at Charlotte, N. C.

THE TRANSMISSION OF POWER BY MANILA ROPE.

By W. B. Hosford.

From the earliest known mechanical history, when the wood turning lathe was operated by bow and string, and water was pumped out of mines, with single-acting condensing walking-beam engines without shaft or flywheel and with valves operated by strings and pulley, down to the present time, various forms of apparatus have been devised for transmitting the power developed from one shaft to others in its immediate vicinity.

At the beginning of the power transmitting and engineering period, speed, or revolution of shafting, was slow. Shafts were made of wood with some form of trunnions for bearings running in wooden boxes, and wood toothed gears of various forms were most commonly used, if indeed any other system was known.

This condition was unfavorable for the introduction of extended lineshaft with any form of transmission, and motors, either steam or water power, were directly connected to the machine or plant to be driven.

After the wood gears mentioned, cast iron gears were used sometimes in trains of a number of spur wheels in line operating on short idle shafts to convey power from one point to another.

Chains, Belts and Ropes.

Later, and to avoid excessive loss of power by friction and eliminate the cumbersome gearing, attention was directed to other forms of transmission. Chains operating on wheels with special grooves to receive the links, leather straps or belts and, lastly, ropes were used. A few of us can remember the old style flutter water wheel, where the water was admitted from a flume to a square box of heavy plank, with large round holes in opposite ends through which an octagonal shaped wooden shaft was placed. Upon this shaft were two peculiarly shaped wheels, with spoon buckets adjusted to turn the shaft, one wheel in each of the openings mentioned. The water rushing out of the box, under pressure due to 8 or 10 feet head, caused the shaft to revolve, but at an extravagant expenditure of water.

When a boy I frequently visited an old saw mill, operated by one of these wheels, which drove a sash saw making about sixty strokes per minute. The sawyer would set the head end of the log and start the feed works and the saw to cutting, then leisurely walk around and set the tail end, then go over to the house and back while the saw was cutting off a board.

Later at this mill the water supply became inadequate and the old wheel and sash saw were torn out and a new and, for that time, an up-to-date center-discharge turbine wheel put in, with vertical iron shaft and mortise gears to a horizontal iron shaft with a large driving pulley belted to the crank shaft of a muley saw, running about two-hundred strokes per minute, which cut two or three times the lumber produced by the old mill, and with half the water.

Continuous Progress.

Thus we note the improvement in engineering away back in 1852. But improvements in engineering and manufacturing did not stop way back there; they have been moving right along in various branches of industry ever since, until now we see saw mills turning out a hundred thousand feet of lumber a day; ponderous factories turning out thousands of yards of yards of cotton cloth; immense mills handling the seed from the cotton that produces the cloth, making barrels of oil and tons of oil cake; and other indus-

tries too numerous to mention, all using up-to-date machinery appliances, driven by belts or manila ropes.

Belting has been the approved, and most common medium of transmitting power for many years past.

Wire ropes have claimed the attention of engineers, and for a time filled the requirements in many important installations, but there are some serious objections to the successful operation of that system. Substantiating this statement, we note a gradual decline in the use of wire rope for transmission purposes in general.

On the other hand the use of manila rope is growing in favor all along the line. There are two distinct plans or systems of manila rope drives in use at the present time for the transmission of power, viz: the so-called English or German system, and the American system.

Systems of Rope Driving.

The English system consists of a number of separate and independent loops of rope running side by side in separate parallel grooves with no other tension than that caused by their own weight in suspension between the wheels upon which they run. This system we learn was introduced in England about 1865 by James Combe, who commenced at that time his experiments with hemp and manila rope. And from then on to the present, the use of manila rope for transmission of power, especially in large units, has gradually increased.

In 1883 a marked advance in this art was made by the Dodge Manufacturing Co. in an improvement on the so-called English system and designated the Dodge American System.

This system uses but one continuous rope, wound over the driving and driven wheels as many times as required to transmit the power, the return rope on the slack side forming a loop over a winder and traveling or flexible tightener. This tightener is controlled by a weight so that it may automatically regulate the tension in all the wraps of rope.

The American system has been improved greatly since its introduction, as experience and study have developed it. The English system requires a splice in every wrap of rope. In the Dodge American System, the rope is one continuous piece, requiring but one splice.

Tension for Driving.

The English system depends upon gravity for tension; hence, to increase the tension larger diameter ropes must be used to augment its weight. The slack side of these ropes being loose, they vibrate and have a tendency to jump out of the grooves. To overcome this, deep grooves with high partitions are made in the wheels. These conditions increase the cost of the wheels, as heavier rims to accommodate the deep grooves are required. Larger and heavier rope must be used. The expense of added number of splices, handling larger and more cumbersome rope all combine to discourage the use of the English system.

To splice a multiplicity of ropes and secure a uniformity of driving effect, is difficult if not impossible, because the shortest loops will carry the burden of the load and are subject to rapid wear and liability to breakage. Again, the ropes carrying the heaviest strain would not travel evenly with the looser ones, causing a differential in case of a difference in diameters of driver and driven, which would produce undue wear on the ropes.

The supposed advantage of multiple independent ropes—that any one may break and be spared without shutting down—is nullified by the greater liability to frequent failure of the heavily loaded ropes.

The automatic adjustable tension carriage of the Dodge American System gives better results, by reason of the assured uniformity of tension on all of the ropes, relieving the splice of any special strain, such as is thrown onto those of the overloaded ropes in the English system.

In the American system, the tension being regulated automatically, the ropes run without vibration, thus permitting the use of shallower grooves, lighter wheels and lighter rope, and producing a saving in the power required to revolve the heavier (English groove) wheels, and a saving in friction.

Rope Drive Design.

The Dodge American System, under the direction of an experienced engineer, can be designed to drive in any direction or at any angle. A building may be isolated at any convenient distance from the power, the machinery set up as desired and the drive designed to suit, leading the ropes in the most convenient line.

It has been said that "a little knowledge is a dangerous thing." This is quite true in designing rope transmissions. The engineer designing a drive may understand the theory, but fail in practice and experience. Experience is absolutely indispensable in this line, as there are no two installations just alike.

Each drive requires individual treatment, from the fact that the speed of shafts, amount of power required, distance between centers, and other varying conditions, differ in every case. In one installation the load and power will be steady, in another fluctuating; each case requiring the utmost skill and recourse to long experience by the most skilled engineer.

Knowledge can be imparted to others, but it is impossible to transfer the experience of one to another—to confer the ability to anticipate unknown conditions before they come up—to impart the experience of the past as guides for judgment in laying out new work where conditions differ from those already covered in practice. Twenty-seven years of experience in designing and building rope drives is a valuable asset to those engaged in that line, but that experience can only be available to others through connections for mutual benefit.

To illustrate: A customer needs a transmission. If at a distance, he outlines his case by correspondence, stating:

- (1) The power required.
- (2) The motive power, whether steam or gas engine or water wheel, or to connect one shaft with another.
- (3) If steam engine, what type and size.
- (4) If gas engine, what cycle and number of cylinders.
- (5) The speed of the driving shaft.
- (6) The speed of the driven shaft.
- (7) Whether the shafts are parallel.
- (8) Whether both shafts are horizontal or either of them vertical.
- (9) Whether the shafts are on the same level.
- (10) If not on the same level, a description of the conditions.
- (11) The distance between centers.
- (12) The largest diameter of driver possible.
- (13) The largest diameter of driven possible.
- (14) Whether ropes may run straight between wheels, or must clear obstructions. If the latter, an explanation of the conditions.
- (15) If angles are required, etc.
- (16) Whether rope will run outdoors or under cover.

(17) The most convenient location for tightener.

(18) The direction of motion.

(19) Sketches of location, etc.

With this information a general knowledge of the requirements is available to the man with experience, who knows which plan is best, "judging by what he knows of the past."

The Value of Experience.

When an engineer has tried a thing, and found it impracticable, he can, if consulted, save the next man no little expense and trouble, by warning him against making the same experiment. Just so with the American system, eminently successful as designed and erected by the originators, who can impart their knowledge, based on long and varied experience. There are many drives, erected by those lacking in experience, that have been disappointing in results, and have had the effect of casting a shadow of disrepute on rope driving generally.

We are not like the patent medicine people, advertising the rope drive as a panacea for all mechanical ills. There are innumerable cases where a rope drive would not be suitable or appropriate, and to know where to draw the line, so to speak, to know when a rope drive would not be the best or most successful means to employ, and to suggest the best substitute, is worth something. If a rope is best for the case, then to know how to plan it to work successfully, having in mind the difficulties to be overcome, the troubles to be avoided, and how to adapt it to the conditions existing is the important thing.

We ask customers to "lean on us in their transmission troubles," and are pleased to report that a goodly number do that very thing, but now and then some unfortunate will come to us with a job so difficult (if not impossible) that everyone else has turned it down, and the party expects, of course, that if every other plan fails, a rope drive would work all right. Not so. Occasionally conditions come up where it would not be wise to consider any of the familiar forms of transmitting power, without making radical changes. Again, we have inquiries for rope drives where strands rub together, rapidly deteriorating the rope.

The tension carriage should be prevented from reaching the end of the track, or the weight from resting on anything. This condition would cause the rope to become slack and run off of the carriage wheel, and might do some damage.

During a dry time ropes will stretch and be longer, but the carriage will take up this increased length. but if near the end of the track at the beginning of the dry time, it will go the end in short time if not looked after. In taking up or shortening the rope during a dry spell, the splice should be made so as to let the carriage away from the inner end of the track and so allow room to travel forward as the rope shrinks in humid atmosphere. Weight rope sheaves need lubricating to reduce friction and wear, and make the carriage more flexible and sensitive.

Ropes should not become dry or fuzzy on the outside. There are several so-called dressings on the market, many of them causing a rope to be more or less greasy and non-adhesive. The Dodge AA-A1 rope dressing, applied hot, properly lubricates the rope between the strands and leaves on the surface an adhesive skin of a rubbery nature that prevents slipping and protects the rope from wear.

Ropes running out-of-doors need dressing more carefully than those in buildings. This dressing should never be applied when rope is damp, as it will cause mildew and rot. For out-door drives, a very dry spell

is the best time to treat with dressing, which, when properly put on, will prepare the rope for a long, hard winter.

Splicing the Rope.

There are two kinds of splices used. (A) The sail-maker's splice, so-called, which is short and effective, requiring but little time to make, and most convenient when starting a new rope, which will stretch more or less and require taking up before long. (B) A long splice; not the common long splice that the sailors are accustomed to make, but a splice adapted to this special service. This splice is put in after the rope has run a few days and worked down to normal conditions.

To those who are not familiar with making splices, this detail may seem more or less difficult and depressing. Not so. Anyone who will devote an hour to careful study of the art can make a perfect splice, as when carefully looked into the matter becomes as simple as lacing a belt properly. In fact, we would prefer to teach those who had never seen a splice made, than attempt to induce a sailor to give up his established method and adopt the correct plan.

Uncoiling Without Kinking.

Those who are using ropes may have experienced some little trouble and annoyance in taking a new

A MODERN CONCRETE GRAIN ELEVATOR.

In considering the possibility of fire loss in buildings of any sort it is hard to find any class of building which is exempt from destruction by fire. Grain elevators, however, are particularly liable to loss by fire since, when built of wood, as is usually the case, both the structure and its contents are highly inflammable. The tremendous losses in elevator fires in Chicago and other grain centers in recent years are probably responsible to a large degree for the growing popularity of fireproof elevators.

An illustration of a modern type of fireproof elevator is that of the Sparks Millin Co., at Terre Haute, Ind., shown herewith. This property had been owned by the Willard Kidder Mill Co., and was purchased by the Sparks Milling Co., in September, 1909. Work was begun on the new concrete elevator on October 1 and it was practically completed, excepting for the installation of the machinery, by December 5, 1909, and was in complete operation in the early part of February, 1910.

The total storage capacity of the elevator is 150,000 bushels. It contains four large bins of 30,000 bushels capacity each, the balance of the storage space being



Reinforced Concrete Elevator, Sparks Milling Co., Terre Haute, Indiana

rope out of the coil. There is one way the rope can be taken out without twisting and kinking, yet without putting the coil on a reel and revolving it, which is no small job with a large coil. It is done thus: Find the side of the coil where the end of the rope is in the center hole; turn the coil over, bringing that side down on the floor, reach down through the center and pull that end out through the top, and the rope will come out smooth and without kinks.

divided up into seven smaller bins. The power plant and operating machinery are situated in the annex or scale house extending across the ends of the storage bins at the ground level. This part of the building also contains a scale of 1500 bushels capacity.

The machinery and equipment throughout is of the most modern type and the entire operation of the elevator may be controlled by one man who, it is claimed, may stand in the scale house and control all

the elevating and conveying machinery without moving four feet from his position.

The elevator was designed and built by the Macdonald Engineering Co., of Chicago, the machinery being furnished by the Skillin & Richards Manufacturing Co., also of Chicago. 3,000 barrels of cement was required for the completion of the work.

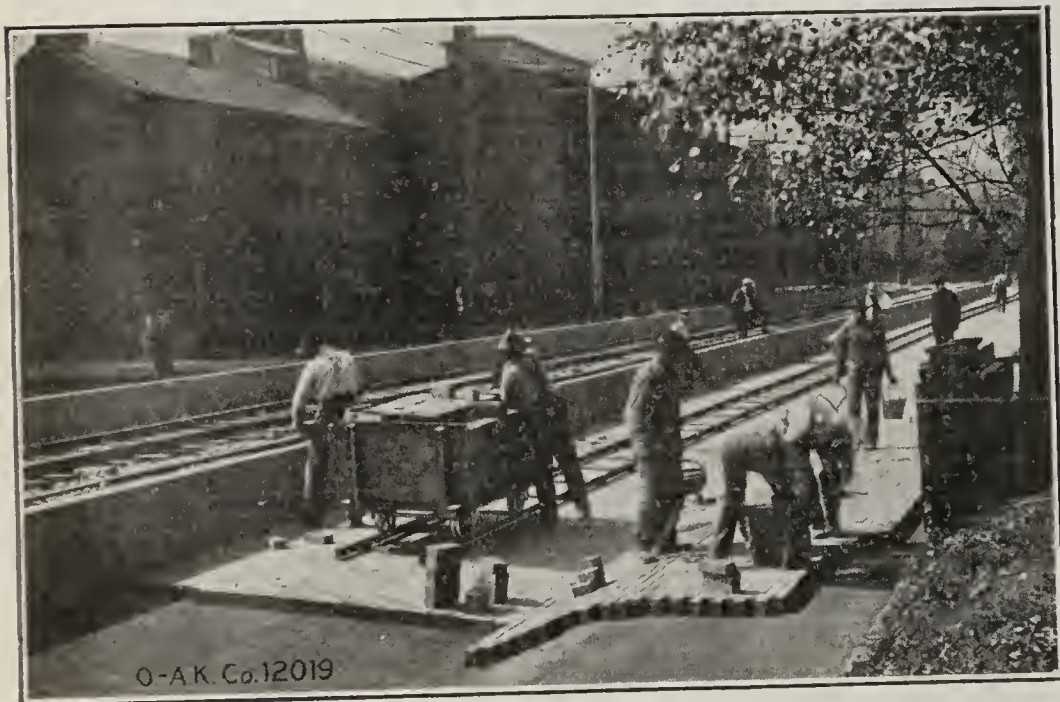
LAYING A PAVEMENT UNDER DIFFICULTIES.

The town of New Brighton, Pa. boasts of a splendid stretch of brick pavement laid by Contractors J. H. & M. E. Miller of New Castle, Pa., who met with unusually adverse conditions in the work.

On one side were street car tracks with a concrete guard wall about two feet high; on the other side trees and lawns. Wheelbarrows were too slow—teams would cut up the sand bed and have difficulty in moving around.

Messrs. Miller looked the situation over and decided that it would not be advisable to move any part of their plant from New Castle to New Brighton. They leased cars and portable track and switches from the Orenstein-Arthur Koppel Co., whose general offices are in Pittsburg. The result of this move is interesting to anyone engaged in similar work. The paving material was handled in record time and the percentage of damaged bricks so low that it was not considered. This saving in labor cost was from thirty to forty per cent which means just that much more profit than would have been made if old style methods had been used. The job was completed long before the stipulated time owing to the time gained and the better condition of the material delivered by the method employed.

There was no capital tied up in the equipment and Messrs. Miller gained prestige as a result of the early completion of the contract.



SOME EXPERIMENTS ON THE DURABILITY OF CEMENT DRAIN TILE.

By Prof. W. H. Day, Agricultural College, Guelph, Ontario.

Since the Ontario Agricultural College began college extension work on the subject of farm drainage some five years ago there have been numerous inquiries for information on the subject of cement tile. People usually wanted to know two things: first, whether the cement tile could be made cheaper than the clay tile, and second, whether they would be durable. When these inquiries first began to come in

there were not, so far as I am aware, any extensive or conclusive data as to the durability of cement drain that they should prove durable, judging from the manifold conditions in which concrete had proven its utility, nor was there any grave question about their durability. There was a general impression, however, fulness.

In the latter part of the year we learned of the controversy over the durability of the cement drain tile, and we must confess that the idea of cement being soluble was a new one to us. After reading the attack on cement and the answer to it we counselled our farmers to go slowly in the adoption of cement tile, believing that the uncertainty in our own minds at least about their durability was sufficient to warrant such action. At the same time, however, we decided to conduct some tests in order to learn for ourselves something about the solubility of cement, and to deduce from the information thus obtained some idea of the probable durability of cement tile. Those experiments were begun in February, 1909, and have been continued until the present time. Besides the points already mentioned, the porosity of cement tile received some attention during our experiments.

Experiment I.—Sample, a piece of tile weighing 43.256 grams, after being dried to constant weight at 215 degrees F. This tile was made by the "dry process" in April, 1908, in proportions of 6 of sand to 1 of cement. For a few days after being made it was watered daily, and then it was submerged in water for a period of six weeks, after which it was removed and transferred to a storage cellar, where it remained until solubility experiments began. Tile quite porous. After the small piece had been dried to constant weight it was placed in distilled water for four days, then removed, dried, weighed, and again placed in fresh water. As convenience allowed it was dried, again weighed, and once more placed in fresh distilled water. This was repeated sixteen times, the total period of solution being 148 days and the total loss in that time was 0.113 grams. The total cement in the sample was 7.174 grams, hence at this rate the cement would all dissolve in 27.7 years. The experiment was next performed with water from the artesian wells at the college. This water is high in total solids, about 460 to 480 parts per million, made up chiefly of bi-carbonate of calcium, bicarbonate of magnesium, or the compound bicarbonate of calcium and magnesium. There is also a small amount of chlorine in it. The sample was tested five times in this water, the total period of solution being 47 days and the total loss in weight .090 grams. At this rate it would take only ten years to dissolve all the cement in the sample.

Experiment II.—Sample, a piece of tile, proportion 6 to 1, made on London two-piece machine May, 1908, watered daily for a week after making, stored in cellar till November, 1909, mixed much wetter than sample used in experiment 1, so wet, indeed, that the molds would not clean well. Dry weight 43.213 grams. The treatment was the same as in experiment I, only the number of tests in distilled water numbered 8 instead of 16, the total period in the water being 73 days. During the period the sample lost .025 grams, at which rate it would take 57.4 years to dissolve all the cement in it. When put in the well water the loss in 47 days was .090 grams, which rate would use up all the cement in 10.3 years.

Experiment III.—Sample, a piece of wet mixed tile, made the same time as No. 2 and watered and stored in the same way. Dry weight 36.2795 grams. Treatment, distilled water for 73 days, well water for 47 days. This sample lost only slightly in distilled water

and gained .0333 grams in well water. At this rate it would last forever.

Experiment IV.—Sample, a piece of tile, proportions 4 of sand to 1 of cement, made by Mr. George Holden, of St. Marys, on the London Automatic cement tile machine. Watered daily for a week after being made, and then stored in our laboratory until October, 1909. Dry weight 20.4792 grams. Treatment, same as II. and III. Loss in distilled water in 73 days=.0387 grams. At this rate the sample would last 26.5 years.

Experiment V.—Sample, a piece of tile, proportions 4 of sand to 1 of cement, made by same maker as No. II, cured and stored in the same way. Dry weight 35.781 grams. Treatment same as others. In 73 days in distilled water the loss was .0175 grams, at which rate the sample would last 102.2 years. In 47 days in well water the sample gained .0165 grams in weight, and thus would never disintegrate.

Experiment VI.—Sample, a piece of clay tile, about average quality, possibly burned a little slack. Dry weight 36.660 grams. Treatment in distilled water 48 days, weighed 5 times, in well water 47 days, weighed 5 times. Loss in distilled water 1.159 grams, at which rate the sample would last 9.1 years. Loss in well water .081 grams, at which rate the sample would last 58.3 years.

In estimating the time that sample would last it has been assumed that they would be subject to solution 365 days in the year and that the rate of solution would be uniform. The first of these conditions certainly would not hold in practice. During a large portion of the year, possibly half, tiles are dry and not subject to solution, and consequently would last twice as long as the periods mentioned, provided the rate of solution during the other half of the year was constant.

We had hoped to establish something definite as to the rate of solution, but we have failed to do so yet. The rate of solution seems to fluctuate with some factor other than time, probably temperature. Just when our curve for rate of solution would reach a constant for two or three readings, this variation would occur and prevent conclusions. In all samples the rate of solution in distilled water appeared to fall off, slowly in most cases, but very rapidly in a few, especially in the case of the clay tile. When placed in the well water the samples all behaved irregularly at first, giving either large losses or else large gains, and these losses or gains fell off rapidly.

Three other experiments were performed which probably come nearer natural conditions than the previous experiments do. Three half tiles were placed in water on May 6, 1909, where they have been ever since. At the end of six months they were dried, weighed, replaced in the water. Then last week they were dried and weighed again. The results are as follows:

Experiment VII.—Sample, a half tile, proportion 6 to 1, made on London two-piece machine, dry process, May 1908, watered for a week, stored in cellar. Dry weight 1797.5 grams. Treatment, in running well water for 10½ months, weighed at 6 months and at 10½ months. Result, tile gained in weight each time, total gain 3.4 grams.

Experiment VIII.—Sample, same as in 7. Dry weight 1910.25 grams. Treatment, same as 7. No change in weight in first six months, a gain of 4.05 grams in next 4½ months.

Thus these two samples would never disintegrate at this rate.

Experiment IX.—Sample, a half tile, proportions 6 to 1, made on London two-piece machine, made very wet, so much so, indeed, that tile would not hold shape,

and moulds would not clean. Allowed to dry, getting a few showers of rain, and then stored in cellar. Dry weight 2001.0 grams. Treatment, same as in 7 and 8. Tile lost 1.90 grams first 6 months and 2.7 grams next 4½ months. At this rate the sample would last 63.4 years.

It is worthy of note with regard to these three samples that those made by the dry process, and therefore very porous, were the ones to gain in weight, while that made by the wet was the one to lose.

The behavior of these three large samples contrasts so strangely with that of the small samples as to indicate that experiments with small pieces are apt to be very far from actual conditions. For instance, the rate of solution for the piece of clay tile would indicate that that sample would all dissolve in less than two generations. And in much less time than that the tile would be so weak as to give way under soil conditions. Experience has shown that such does not occur, and hence we must conclude that the conditions are so artificial that it is not safe to base arguments as to durability upon such tests. It is even doubtful whether the large tile in running well water is very close to natural conditions. In the soil there will be much very fine sediment in the form of clay and colloid particles to lodge in the pores and prevent solution. The process of accretion shown in two out of three of these large samples would doubtless be much more rapid in the soil. Another reason for the slower solution in the large samples was the cooler temperature maintained by the constant introduction of cold water. Basing our conclusions on these larger samples we are not able to see any danger of the cement tile crumbling.

Porosity.—With regard to the porosity we find that it varies with the proportions of cement, with kind of sand used, and also with the method of making. The more cement used, the finer the sand, or the wetter the mix, the less porous the tile. But even the most compact ones tested were much more porous than clay tile.

MORE ORDERS FOR SCAIFE'S WATER SOFTENING AND PURIFYING SYSTEMS.

That operating steam boilers with bad feed water is wasteful and dangerous, every live engineer will admit. It takes but little common sense to realize that to obtain the full efficiency of a steam plant, the boilers must be clean all the time. That the boilers can be clean only by feeding them with water free from scale-forming and corroding substances is self-evident.

That steam plant owners are realizing more and more the necessity of clean boilers is evidenced by the number of orders placed with Wm. B. Scaife & Sons Co., of Pittsburg, Pa., manufacturers of the Scaife and We-Fu-Go Water Softening and Purifying Systems, not only for steam boiler feed use, but for other industrial uses. The following are some recent orders for the Scaife and We-Fu-Go Systems received by them:

Carnegie Coal Co., Oakdale, Pa., 750 H. P. We-Fu-Go System.

Boston Rubber Shoe Co., Fels, Mass., 900 H. P. Syphon System.

Twin State Gas & Electric Co., Dover, N. H., 575 H. P. We-Fu-Go System.

American Sheet & Tin Plate Co., Gas City, Ind., 1800 H. P. We-Fu-Go System.

Wickwire Steel Co., Buffalo, N. Y., 3000 H. P. addition to present 6000 H. P. We-Fu-Goo System.

Cleveland Hardware Co., Cleveland, O., 1000 H. P. We-Fu-Go System.

A REINFORCED-CONCRETE LOW-HEAD WATER TANK AND ITS WATER-PROOFING.

By H. F. Blomquist.

The city of New Ulm, Minn., has just completed a reinforced-concrete reservoir of 1,000,000-gal. capacity, a cylindrical structure 75 feet in diameter with the walls 30 feet high, and covered with a conical concrete roof. The ground on which the reservoir is built consists of hard clay well drained by natural drainage, and upon this clay was spread a layer of stone with an average thickness of 12 inches the voids of which were filled with a wet, fine-grained concrete poured in. This formed the foundation for the floor which is ten inches thick, and reinforced near the surface with expanded metal of No. 16 gage thickness and 3-inch mesh. The floor is bound to the walls by means of 1-inch round steel rods 8 feet long bent so as to extend 4 feet into the floor and 4 feet up into the walls. These were placed 12 inches apart throughout the circumference.

The walls are 20 inches thick at the bottom and taper to 15 inches at the top, with the batter on the outside. They are reinforced with 123 $1\frac{1}{8}$ -inch and 40 1-inch round steel rods rolled to the required radius and placed horizontally, and by 20 upright supports made of steel angles with lacing bars, which served as supports for the horizontal rods during the time of construction, as well as vertical reinforcement in the walls. The horizontal reinforcement is sufficient to take all the stress without assuming tension in the concrete, or counting on the support of the earth embankment on the north side.

The roof consists of a conical concrete slab 3 inches thick and reinforced with No. 12 gage, 3-inch mesh expanded metal, and is supported by eight trusses radiating to the wall from a center pillar. The trusses are bound together with steel I-beams as purlins 5 feet apart. The steel trusses are 6 feet high from c. to c. of chords at the ends which rest on the center pillar, and taper down to 3 feet at the ends resting on the walls.

Since it was of the utmost importance that the walls and the floor should be water-tight, special care was taken during the construction to grade the aggregate for the concrete. It has been found by experiments that the densest concrete can be made when rounded pebbles carrying in size from about $\frac{1}{4}$ -inch to about $2\frac{1}{2}$ inches are used instead of broken stone on account of the ease with which such pebbles will move about in a quaking mixture while it is being worked in place, and adjust their positions so as to form the least amount of voids. For this reason pebbles were screened from a gravel bank and used instead of crushed stone for the walls and upper part of the floor, and the sand used was a mixture of very coarse and ordinary fine sand. To reduce the permeability of the concrete to a minimum, 20 lbs. of hydrated lime was used to every barrel of cement, and after the forms were removed the walls were brushed and cleaned with steel brushes, and two coats of cement plastering were applied to the inside. The mortar for the plastering consisted of one part cement, two parts of sand, hydrated lime to the extent of 10% and Medusa waterproofing compound to the extent of 3% of the cement used.

The proportion used for the concrete in the walls and the upper 4 inches of the floor was 1:2:4 and this proportion of concrete together with the plastering has

apparently made the walls water-tight, as no leakage has been noticed up to this time except a small leak in the bottom shortly after the reservoir was filled, which was due to an imperfect bond at one point between the old and new concrete. This however did not cause serious trouble.

The forms for the walls were made in sections about 12 feet long by $2\frac{1}{2}$ feet high, and the inside and outside parts were bound together by means of $\frac{1}{2}$ -inch rods extending through the walls, which were removed after the concrete had acquired its initial set. The holes formed by the rods were afterwards filled with strong cement mortar. Only one round of forms was used, as the contractor found that he could work most economically filling the forms in one day and removing them the next, and set them up for the pouring of concrete again on the third day. When it was necessary to build scaffolding two days were taken to remove and set up the form and build scaffolds.

The bond between old and new concrete was made by brushing the old concrete thoroughly clean and pouring on a neat cement grout just before pouring on the new concrete.

The outside walls are protected by an earth embankment which extends to within 10 feet of the high water mark and has a slope of 2 to 1 on the outside. This was sufficient protection during the past winter to keep the water from freezing.

SKILL REQUIRED TO COLOR CEMENT.

Experts Give Advice on Obtaining Uniform Surface and Decorative Effects.

The difficulty of obtaining an even grained surface of uniform color on concrete work is one of the hardest which builders of concrete structures have to overcome. Concrete work is subject to many sorts of surface imperfections, of which the two most common are roughness or irregular surface texture, and discoloration or variability of color. Either of these disfigurements will spoil the appearance of an otherwise beautiful structure and the task of avoiding them is one that is occupying the attention of all who are building in reinforced concrete.

Unfortunately, the business of building in concrete is still in its infancy, so no regular set of rules have as yet been drawn up that can be followed to prevent with absolute sureness these two highly objectionable features. But experience has taught that certain causes produce certain results and the causes of discoloration can be eliminated by the careful workman.

Causes of Discoloration.

Some of the causes of discoloration are obvious and others are difficult to determine with any degree of exactness. Roughness or uneven surface texture is a common cause of variation in color, since the alternate rough and smooth parts weather differently and collect and hold dirt and soot in different degrees. Another cause of discoloration is the use of different cements or different mixtures of cement in adjacent parts of the surface. No two elements are of exactly the same shade nor are any two different mixtures alike in color and the concrete made of the various cements partakes of the variation. In the same manner, sand of different shades of color or of different degrees of cleanliness will cause a streaky appearance in concrete surface. Dirt adhering to the molds will also frequently stain the exposed parts.

Even when the smoothness of the surface is satis-

factory and there is no criticism possible as to the kind of cement or sand used and their disposition and the cleanliness with which the work is done, concrete surfaces frequently vary in color and have cloudy light and dark appearance. In many cases there seems to be good reason for attributing this to the bleaching out of lime compounds and their disposition as a form of deposit on the concrete surface. The extent of this efflorescence varies.

At times this deposit is so thin that it merely gives a lighter shade to the surface where it appears, and at others it will often form an encrustation of considerable body and thickness, which may be scraped off in the form of a thick white or yellowish powder.

From Cement Authority.

An authority on the chemistry of cement has said in relation to this form of discoloration:

"It is primarily due to the variations in the amount of water used in the mortar of which the cement is composed. It will be readily understood that when any excess of water is used, segregations of the coarse and fine particles will take place, with a resulting difference in color. When a large amount of water is used, the concrete is more porous, and the considerable percentage of lime liberated from the Portland cement in the course of setting is more readily brought to the surface at such a point. The amount of water in a cement, the surface of which is to be exposed, should neither be too small nor too large, but such a surface should not be allowed to harden dry or the surface will be honey-combed.

"Where the greatest care is used as to the amount of water added to the mortar, and to prevent its loss, and where separation of the mortar from the broken stone or gravel is carefully avoided in depositing the cement and ramming it in, the exposed surface after the removal of the molds, is fairly uniform in color. A more uniform color will always be obtained when some puzzolanic material is ground in with the cement, such as slag or dross. This hydrated silicious material combines with the free lime which has been liberated and prevents its being washed out onto the surface. Exactness in the amount of water used in the concrete, when the elimination of the stain caused by the free lime is considered desirable, and the addition of some substance containing silica in an active form, are the two steps to be taken to produce a concrete surface which should present a uniform color and pleasing appearance."

To Prevent Discoloration.

The measures whose adoption are recommended in the quotation just made are designed to prevent the occurrence of efflorescence by adopting certain precautions in the materials and workmanship of the original structure. Their adoption, however, if it gives the degree of success anticipated, is obviously the way to get at the root of the trouble, but such action involves a degree of skill and watchfulness which is difficult to attain under ordinary conditions or engineering construction and which if attained will add materially to the cost of the construction. In default of the preventive measures, which recommend themselves to general use, the engineer who encounters trouble by efflorescence, must overcome it by remedial measures. There are several available. The most practical ones are the washing of the discolored surfaces with some solution which will remove the incrustation, or the removal of the original surface by dressing it down with hammers or tooling of some sort.

Cleaning a Bridge.

The following account of the method of the cleaning of a concrete-steel bridge at Washington, D. C., gives instructive data as to this mode of procedure: The bridge had a mortar facing and after this was completed a heavy rain caused the entire north facade to become discolored by efflorescence. This discoloration was not uniform, but was in streaks and blotches of white, which soon turned into a dirty yellow.

To clean the bridge, trial was first made with water and wire brushes, but after a little work this method was considered impractical, owing chiefly to its cost which was estimated at \$2.40 a square yard. Washes of diluted hydrochloric acid, of diluted acetic acid, and of diluted oxalic acid were then tried in conjunction with ordinary scrubbing brushes.

The hydrochloric acid wash proved to be the best, and the acetic acid came next in efficiency. The wash finally adopted consisted of a solution of one part hydrochloric acid and five parts water. This was applied vigorously with scrubbing brushes, water being constantly played on the work with a hose to prevent the penetration of the acid. One house cleaner and five laborers were employed on the work, which cost 60 cents a square yard. This high cost was due largely to the difficulty in cleaning the balustrades. It is estimated that the cost of cleaning the spandrel and wing-walls did not exceed 20 cents a square yard. The cleaning was thoroughly satisfactory. Some of the flour removed was analyzed and found to be silicate of lime.

BIG CONCRETE SCOWS.

To be Used in Deepening the Canal at Panama.

The soft material dredged from the shallow lakes and river along the route of the Panama Canal must first be deposited in some sort of floating receptacle, which can be hauled to a place where it can be used in building an embankment, or else be taken out to sea and dumped. For this service scows, or barges, are employed, and when they are full they are moved by steam tugs.

Three scows, made of reinforced concrete are to be built by the government engineers for duty on the Pacific division of the canal. They are to be 64 feet long, 24 feet wide and 5 feet 8 inches deep. As it is not intended to devote the whole interior space to mud and sand, a large compartment will be constructed inside each scow. The side walls of this will reach from end to end, but partitions will be so placed that the compartments will be only forty feet long. Both the boat proper and the walls of the inner receptacle will be strongly reinforced with wire cloth and steel rods.

This type of vessel was first constructed in Italy. So satisfactory was the behavior of the concrete, both in small boats and in barges, that other countries are beginning to follow Italy's example. Concrete is more durable than wood and can be made waterproof. At Owensboro, Ky., a huge concrete box, upside down, is used as a landing platform at which boats may discharge passengers and freight. This floating dock is 50 feet long, 16 feet wide and 3 feet deep. To insure buoyancy in case of an accidental puncture the box is divided into thirty compartments.

The Panama barges, when fully loaded, are expected to sink into the water only three feet. Besides mud and sand they will carry two or three tons of machinery. The latter will include a dredging pump and a motor of some sort for driving it.

NEW SYSTEM OF CONCRETE CONSTRUCTION.

The plan of the Duval-Schub Concrete Construction Company, of Jacksonville, Fla., embraces the construction of houses all sizes and architecture, by means of the Schub Metal Molds.

The members of this company believe that concrete is the coming material for building in this as well as in all other climates, but that is particularly good for warm climates where the sun soon eats off paint and rots frame structures at a very rapid rate, making them deteriorate to just this extent.

The company have in mind the construction of a concrete bungalow colony along the lines of similar colonies in California.

Jacksonville, you may know, is growing faster than any other city in this section of the country and we anticipate doing quite a business.

Following are the officers of the company:

President, James Coons; vice-president, Stockton Broome; secretary and treasurer, C. S. Cowenhoven. Directors, the above and J. A. Ewing and W. P. Smith.

Concerning the system employed by this company, C. S. Cowenhoven, secretary-treasurer, advises:

"Schub's unit system of interchangeable metal molds is the best and only practical system of metal molds in existence for the construction of absolutely fire-proof concrete construction buildings.

"The molds are adaptable to the construction of any size, class or design of building, from a small cottage to a skyscraper, factory or railway terminal—anything that would be called a building. There are no restrictions on design as the moulds could be set up in the form of the walls of Troy or a Chinese puzzle if desired. They meet every requirement of concrete building construction. They have been seen by a number of expert concrete engineers and superintendents, and so far none of them have even attempted to offer a criticism.

"Hundreds of concrete buildings of all kinds have already been constructed, from cottages to skyscrapers sixteen stories high, and others 1,000 feet long. All of these have been constructed with expensive wood molds, the cost running from 40 per cent to 70 per cent of the job. With Schub's Metal Molds the cost would run from 5 per cent to 7 per cent. Wood molds require an immense amount of lumber which is afterwards thrown away. Schub's molds are used over and over again.

By the use of Schub's system absolutely fire-proof buildings can be constructed at much lower cost than good frame. Sand and gravel are plentiful and cheap, costing less than \$1.00 per barrel at the mill, instead of \$4.00 or \$5.00 formerly, when imported.

This material as any one knows, costs less than lumber, and is all that is required for constructing the entire shell of a house, including footings, foundations, walls, floors, partitions, roof, stairways, mantels and baseboards. It is only necessary to add to this the doors, windows, heating and plumbing to have a complete house.

CONCRETE PAVING WORK AT MASON CITY, IOWA.

During last summer some 6,000 square yards of Portland cement concrete pavement was laid at Mason City, Ia., under specifications prepared by F. P. Wilson, city engineer, at a cost to the property owners

of \$1.26 per square yard. This pavement was laid in a number of wide alleys where traffic is very heavy. The pavement stood the severe winter in good shape and is now in first class condition. As a result, contracts were let this year for 45,000 square yards of the same kind of pavement, the contract price being \$1.25. Plans are also under way in the city engineer's office for about two miles of this pavement to be laid next spring. The prices for material and labor for the 45,000 square yards now under construction are as follows: Crushed stone, delivered on the street, \$1.35 per cubic yard; sand delivered on the street, 85c per cubic yard; cement on the work, \$1.20 per barrel; labor, \$2 to \$2.50 per day.

The pavement includes a 1:2:5 Portland cement concrete foundation, 5 inches thick after compacting. The specifications require that the concrete for the foundation shall have such a consistency that when rammed the mass will not shake like jelly, but will, when struck, compact within the area of the face of the hammer without displacing the material laterally. The concrete is required to be placed immediately in the work and is spread and thoroughly compacted by ramming until free mortar appears on the surface, which is made smooth and parallel to the surface of the finished pavement. No retempering of the concrete is permitted and concrete in which the mortar has begun to set is rejected. It is required that extreme care be taken that the sub-grade is kept moist while this concrete is being put in place, and it is further specified that no concrete shall be laid when the temperature at any time during the day or night falls below 35 degrees above zero.

PAINTING CONCRETE STRUCTURES.

The oil-destroying properties of the alkali in cement have caused trouble in painting concrete, which can be overcome by a method described by Mr. Charles Macnichol in the paper presented to the American Society for Testing Materials last month. He used it successfully for some years and recommended it as simple and reasonable in cost.

The method consists in treating the cement surfaces with a solution of equal parts by weight zinc sulphate and water, applied with an ordinary bristle brush, after the cement is dry. If the precaution is observed of allowing 48 to 72 hours as a drying period, this treatment will render a cement wall as safe to paint on as an ordinary plaster wall, Mr. Macnichol stated. At his request Dr. A. S. Cushman prepared the following explanation of the chemical reasons for the success of zinc sulphate in such work:

"In regard to the scheme for painting concrete work with a solution of zinc sulphate in order to make the surface hold a paint coating, it is my belief that zinc sulphate is very well adapted for this purpose owing to the fact that when zinc sulphate is brought into contact with the calcium hydroxide (hydrated lime) a chemical reaction results in the formation of calcium sulphate (gypsum) and zinc hydroxide (hydrated oxide of zinc). It is apparent from this that after the surface has become thoroughly dry again, it will contain within its pores a mixture of gypsum and zinc oxide. These materials have no bad influence on linseed oil and, in fact, are frequently used as paint pigments. The reason why such treatment should be necessary before applying a paint coating to the surface of concrete must be apparent to everyone. When Portland cement sets a certain amount of lime is set free in a hydrated condition as calcium hydroxide. This is a strong alkali, and tends to saponify the oil

in the paint coating and thus destroy it. The work done by the application of zinc sulphate is to destroy this alkalinity, and change the calcium hydroxide into a mixture of calcium sulphate and zinc oxide. I do not know of anything that would answer this purpose better than zinc sulphate."

Another action taking place, and an important one to the painter, is the filling of the pores of the concrete, which prevents suction, thus keeping the oil paints applied from penetrating too deeply into the cement.

GROVER REHFIELD APPOINTED ENGINEER AND SUPERINTENDENT OF THE NEW YELLOWSTONE CEMENT PLANT.

Grover Rehfield, formerly with Power & Mining Machinery Company and later with Allis-Chalmers Company and Chicago Portland Cement Company as engineer has been selected by the Yellowstone Portland Cement Company of Chicago as their construction engineer and superintendent for the new cement mill which they are about to build at Gardiner, Montana. Mr. Rehfield, a member of the American Institute of Engineers, the American Society of Engineers, has just left for Montana to assume charge of the work.

The Yellowstone Portland Cement Company will manufacture a white Portland cement, which is much whiter than any "white" Portland cement on the market according to the tests made by a well known engineer.

Power & Mining Machinery Company of Cudahy, Wis., will furnish the grinding machinery. McCully crushers, tube mills, coolers, etc. Raymond pulverizers will be installed and the boilers and kilns will be furnished by the Manitowoc Engineering Works.

JEFFREY'S DENVER OFFICE.

The Jeffrey Manufacturing Company, Main Office and Works, Columbus, Ohio, are changing the location of their Denver office from No. 1111 Tremont Place, and after August 1st will occupy a commodious suite of rooms in the First National Bank Building.

This company besides maintaining a large selling force in over a dozen of the leading cities of this country, also maintain a corps of engineers at their branch offices situated in the following cities: Chicago, St. Louis, Denver, Montreal, Pittsburg, Charleston, W. Va., Boston, New York, and Birmingham.

There are also nearly 100 Jeffrey Agencies in additional cities in this country and abroad.

THE "PERFECTION" CONCRETE MIXER.

The Cement Tile Machinery Co., of Waterloo, Iowa, have just published a sixteen-page catalogue describing the various lines of concrete machinery manufactured by them. It describes more particularly the Perfection Mixer in all sizes for all purposes. In addition there is a great deal of descriptive information given as to the care in mixing concrete and other matters of interest to the contractor and builder. It also contains information in regard to the Schenk cement tile machine, sand-screens, sand elevators, Ideal cars, Easy tile moulds and other lines handled by this company. Copies may be had by writing the company at Waterloo, Iowa.

RUGGLES-COLES DRYERS ABROAD.

Messrs. William B. Ruggles and Robert G. McGann, respectively president and vice-president of the Ruggles-Coles Engineering Company, 50 Church Street, New York, and McCormick building, Chicago, have just returned from a European trip during which they established agencies and sold two 90-inch A-14 dryers, three 70-inch A-10 dryers and one 60-inch A-8 dryer.

NEW CONCRETE SHAFT NEARING COMPLETION.

The New York Foundation Company is just completing an excellent concrete shaft which it has been sinking at the new Woodbridge mine, Buhl, Minn., and they expect to turn it over to the Oglebay-Norton company for operation in a very short time.

The Woodbridge mine is entirely an underground proposition and is owned by the Oglebay-Norton company. It is situated in the Buhl district and is expected to furnish material aid to the rapid growth of this village.

A big cement plant is to be built at Ciudad Jaurez, Mexico, by Americans and American capital. The plant will cost 5,000,000 pesos, and will have a capacity of 2,000 barrels per day. Contract for the work has been awarded the Freeborn Engineering Co., of Kansas City, Mo. During the year 1909, 12,000,000 barrels of cement were imported by Mexico from England and the United States. With the Jaurez plant in operation the imports will be reduced to 750,000 barrels. The plant on the Mexican side of the Rio Grande will have a decided advantage over the plant at El Paso, Texas, in that the products of the Jaurez plant can be delivered to the consumer in Mexico at 15 cents per barrel less than it can be delivered from El Paso, this being the import duty. The United States import duty is 30 cents per barrel.

At the annual meeting of the New Castle Portland Cement Co., New Castle, Colo., report was made that \$40,000 worth of stock had been sold and it was agreed that when \$35,000 more was placed, work would commence on the new 1,000 barrel mill.

CEMENT COMBINE RAISE PRICES.

Taking advantage of the increasing demand for cement, the directors of the North American Portland Cement Company, popularly known as the Cement Combination, have made an advance in the official price of 10c to \$1.53 per barrel delivered in New York. No change has been made in discounts, which will continue on the basis of 1c per barrel on payment within ten days of invoice. From a statement made by a director of the North American Portland Cement Company it appears that the consumption is increasing all over the country and that it is more diversified at the present time than for many months. All indications point to a continuation of this large demand for quite a while to come. The enlarged demand is attributed to the great amount of cement being consumed by the large public contracts and also to the better conditions. Production is running about the same as heretofore.

Another authority states that some of the cement companies are being pushed to their utmost capacity to fill orders in wood. The demand for this package is mostly in New York city and vicinity. It is an unusual condition, but is readily adjusting itself.

NEW CEMENT MILLS.

The Dakota Portland Cement Co., of Sioux Falls, S. D., has let the contract for the construction of its plant at Chamberlain, S. D., to the Freeborn Engineering & Construction Co., of Kansas City, Mo.

The following statement was recently given out by an official of the Atlas Portland Cement Co.: "The largest Portland cement plant in the world is now being built at Hudson, N. Y., for the Atlas Portland Cement Co. The property consists of 1530 acres, located on the Hudson River at the junction of the Boston & Albany and the New York Central railroads, having track connection with both roads. The property extends about 1800 ft. north and south along the river. The plans provide for two units of 10,000 barrels daily capacity each, and the first of which is nearing completion and is now producing 6000 barrels daily, and is expected to be in full operation by Sept. 1, 1910. When the entire plant is finished it will have a productive capacity of over 20,000 barrels daily, or 7,000,000 barrels yearly, more than sufficient to supply all New England. In addition to its regular Portland cement the company will manufacture at Hudson white Portland cement and hydrated lime."

The Mobile Portland Cement & Coal Co., Van Antwerp Building, Mobile, Ala., reports that it has begun the construction of its plant. It writes as follows:

"On the 25th of June the first barge-load of machinery and equipment for the construction of our cement plant at St. Stephens, Ala., was loaded and went up the river on that night, and on the 29th actual construction work began.

"O. Gerlach, Ph.D., is the general manager of construction and operation. Purchases will be made through the Mobile office, and work will be pushed rapidly. The capacity will be 3000 barrels per day. The buildings will be of structural steel, with, in all probability, corrugated iron sides and roof. The spur track on the railroad will be under construction in the next 10 days, and equipment will go to the plant both by rail and water. Coal will be supplied to the plant from the company's own coal property in Tuscaloosa county."

It is reported that the Lehigh Portland Cement Co., Allentown, Pa., contemplates erecting a plant at Mason City, Iowa, to cost about \$2,500,000.

The Fairview Cement Co., of Fairview, Okla., was recently incorporated with a capital of \$100,000. Incorporators: Henry and M. E. France, John J. Nelson, Chas. H. Elbert, and others.

Mr. J. M. Edwards, Spokane, Wash., secretary of the West Coast Portland Cement Company, was in Chicago recently and exhibited a handsome drawing of the West Coast plant as it will appear when completed, near Lewiston, Idaho. This plant has an ideal location, where practically all conveying operations can be effected by gravity, and the raw materials passed down to the mill from inexhaustible supplies in the hills just back of it, while the natural slope of the ground allows the material to pass from stage to stage by gravity, until the finished product is delivered in this manner to a warehouse, or to boats on the river close by.

D. Van Nostrand Co., 27 Warren Street, New York, have just published for Frederick Rings a book on

reinforced concrete. It is 8x5½ inches, contains 189 pages, illustrated and costs \$2.50. The author's principal object in presenting this book is to collect in a concise form what seemed to him best of the many formulae and systems used in various countries, and to deal with the subject in such a manner as to be intelligible to average students of architecture, who have not been required to devote that amount of study to theory of construction demanded of a young engineer. It is hoped, however, that this volume may be of use to the latter.

The formulae are based on the assumption that ordinary, round bars, obtainable anywhere from stock, are used. Some tables and extracts are reproduced from the R. I. B. A. Report on Reinforced Concrete, by permission of the Institute. The history of reinforced concrete is partly compiled from the data given in Tozer's Handbook on the Lock Woven Mesh System, and facts relating to the manufacture and qualities of Portland cement and its use are chiefly from Everyday Uses of Portland Cement, published in 1900 by the Associated Portland Cement Manufacturers. The tables at the end of the book, with the Ready Reckoner, will be a help to the designers and others for reference, calculation and checking of designs.

Bulletin No. 24, recently published by the Association of Portland Cement Manufacturers, Land Title Building, Philadelphia, Pa., is on the subject of "Reinforced Concrete for Houses," by Benjamin A. Homes. This paper was read before the association at the annual meeting last December. It is profusely illustrated and is one of the most comprehensive and best written articles on the subject that has ever been promulgated.

The Fisher Hydraulic Stone and Machinery Company, of Baltimore, Md., desires to inform the public that owing to a fire in their eastern factory it has been necessary to transfer both the manufacture of the machinery and the general working force to the western factory at Mt. Gilead, Ohio, and from this point all business of the company will have prompt and careful attention. All communications should be addressed to the Fisher Hydraulic Stone and Machinery Company, Mt. Gilead, Ohio, direct, saving delays of passing through the office in Baltimore.

The Acton Rock Company of Los Angeles is largely increasing the capacity of its crushing plant and will soon be prepared to furnish large quantities of all sizes of commercial stone. It has recently placed an order with Allis-Chalmers Company which includes the following apparatus: One No. 12, two No. 5 and one No. 2 Style "K" Gates breakers, one 48"x14' and one 48"x24' Gates revolving screens, conveyors and ten induction motors varying in size from 3 H. P. to 175 H. P.

The baghouse of the plant of the Copley Cement Manufacturing Company was destroyed by fire and lightning with its contents, 200,000 bags. Loss \$40,000.

The William G. Hartrauft Cement Company has been appointed general selling agents of the Penn-Allen Cement Company. William E. Erdell who was manager of the Penn-Allen Cement Company for the past five years is now president.

The Ash Grove Lime & Portland Cement Company, is increasing the capacity of its power house at Channute, Kans. When the plant was built the company

installed four Allis-Chalmers 22x42 simple engines. It has recently ordered a 46x42 Low Pressure engine from the same builders, which will serve as a low pressure side of a cross compound engine of which one of the old engines will serve as the high pressure side. The new low pressure engine will be supplied with a rope drive wheel, duplicate of the one now on high pressure engine in order to transmit the additional power generated.

TRADE NOTES.

The Freeborn Engineering & Construction Company, Kansas City, Mo., were awarded the contract for furnishing material and constructing a concrete dam across Little Arkansas River for the city of Wichita, Kansas. Contract price \$25,000.

The United States Department of Agriculture has issued an elaborate bulletin on the subject of concrete fence posts. This bulletin goes into details, gives full and minute instructions enabling the farmers to build their own fences with farm labor.

By applying to the Office of Public Roads, United States Department of Agriculture, Washington, D. C., Farmers' Bulletin No. 403 will be sent without charge.

The Southwestern Portland Cement Company has recently ordered an eight-inch centrifugal pump direct connected to an induction motor from Allis-Chalmers Company. The installation of this set will be particularly interesting because of local conditions.

Power will be transmitted to the motor which will be controlled from the plant about 1½ miles from the location of the motor. Current is generated at 480 volts and stepped up to 2200 volts for transmission

over an existing line. The motor will operate at about 2100 volts.

The pump will deliver about 2000 gallons per minute, against a total head of 80 feet, to a reservoir which supplies the plant. A ten inch riveted steel pipe connects the pump to the reservoir.

CONCRETE SNOW SHEDS.

Snowsheds of concrete are to replace the frame sheds on some railroads in the northern Rocky Mountain region, where the dangers from snow-slides have called attention to the need of more permanent and stronger protection to the tracks. The construction of the concrete snowsheds is to be done during the coming summer, so far as it can be accomplished, to prevent in exposed places any possibility of a repetition of the recent disastrous snowslides which swept entire trains from the tracks and brought death to many, accompanied by great financial loss to the railways. Henry Gruber, an engineer of the Northern Pacific Railway, recently made the following statement as to conditions on that line and the means decided upon to better them:

"The Northern Pacific has many dangerous passes in the Cascade and Rocky mountains where snowslides are a constant menace in winter to the passenger traffic. There are many similar danger spots along the line of the Canadian Pacific. At most of these places the railways have long wooden snowsheds, but these have not proved effective in preventing accidents. In many cases avalanches and immense snowslides have swept these structures completely away, though they were built of the most massive timbers that could be obtained.

N

N

Complete Hand Mixer \$22.

The Most Practical, Thorough, Rapid
and Handiest Hand Batch Mixer Made

Saves Time, Labor & Money

Pays for Itself
in a Short Time

Some Concrete Machinery Bargains

Porch Column Outfits.....	\$ 19.00
Sill and Cap Moulds.....	11.50
Chimney Moulds.....	5.50
Block Machines.....	10.00
Power Mixer.....	50.00
Brick Machines.....	18.50
Well Curbing Moulds.....	5.25
Drain and Sewer Tile Mould.....	5.00
Silo Machine.....	10.00
Ball Moulds.....	2.55

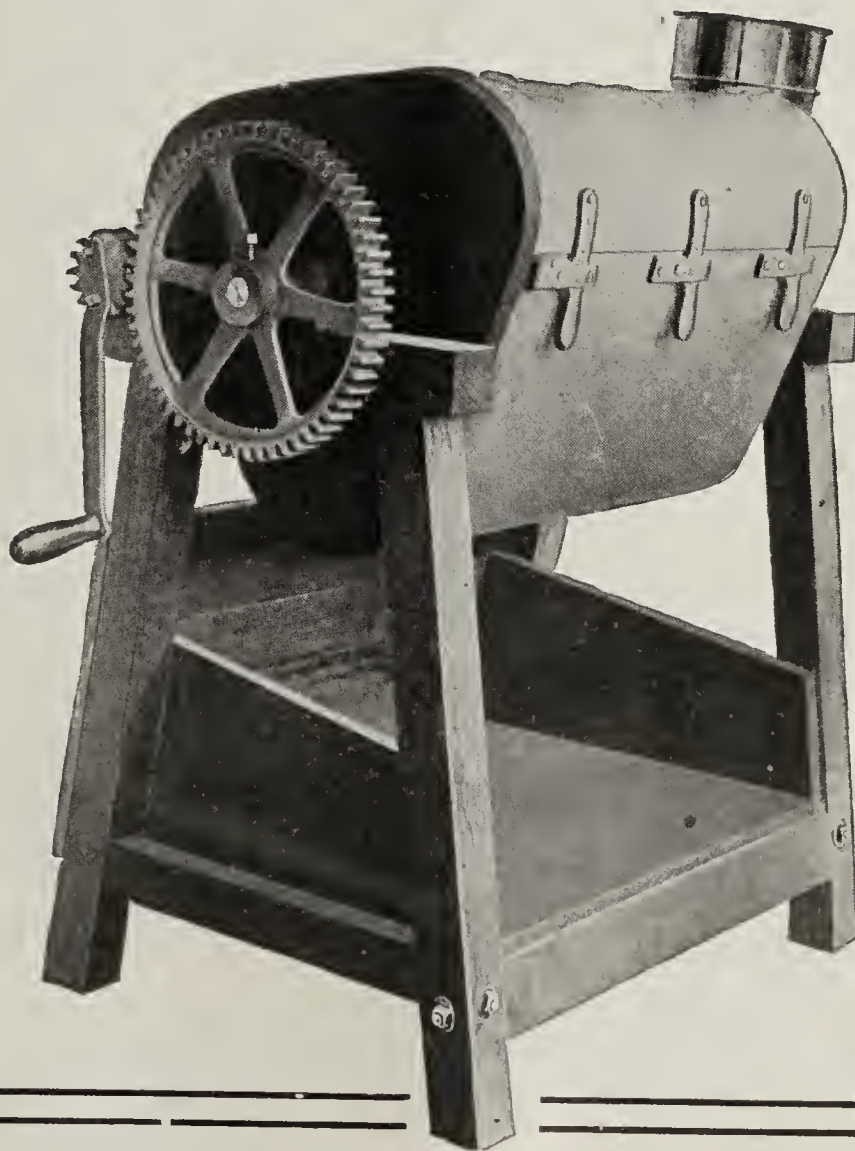
We Make Everything in the Concrete Machinery Line

Send for our Big 1910 Wholesale Catalog. It shows everything that is manufactured in the concrete machinery line and should be in the hands of everyone interested in concrete machinery. Everything imaginable is listed and it is an encyclopedia of what you ought to have and the prices you ought to pay. We are distinct manufacturers and figure prices by the pound. Send for this catalog and keep it as a reference, it costs you nothing.

Northwestern Steel and Iron Works

Box 838

EAU CLAIRE, WISCONSIN



N

N

"The roads have learned that wooden structures won't do, so this summer all these snowsheds are to be replaced with great concrete structures which will be built so strong and enduring that even a cyclone would not be able to budge them. People in the East who have never seen one of the snowstorms of the Rocky Mountains have no idea of the immense mass of snow that covers everything, and they cannot conceive of the violence of an avalanche."

CONCERNING THE CEMENT MILLS.

The Alabama Portland Cement Company, located about one mile from the city of Demopolis, was sold Monday at Linden by Walter C. Benjamin and bought by E. P. Benjamin of New York City. The sale was for the purpose of paying the debts and bonds secured by the first mortgage of deed of trust, together with the cost and expenses of foreclosing. It is understood that just as soon as matters are straightened up, the plant will resume business.

The I. & W. N. began laying track below Lone, Washington, this morning and will have their rails as far as Box Canyon by Saturday night.

The track will be laid into Metaline, Wash., by September first, in order to transport the heavy machinery for the big cement plant now going in at that point.

The Ohio & Western Lime Company's plant at Huntington, Ind. was destroyed by fire. Loss \$100,000. Two large kilns were destroyed. The hydrating plant will be rebuilt at once.

Thomas F. McClaren, formerly with the Western States Portland Cement Company, has accepted the

position as sales manager for the Monarch Portland Cement Company.

The Kansas City Portland Cement Works suffered a fire loss of about \$80,000. A frame building containing the stone crusher, four storage tanks, four belt conveyors, two rotary driers, three elevators and three motors was destroyed.

The explosion of a coal drier at the plant of the St. Louis Portland Cement Company at Prospect Hill, just north of the city limits, Tuesday night, damaged the machinery \$3000. Excessive heating of the coal, which was being prepared for fine grinding, is supposed to have been the cause of the accident. No one was injured.

Mason City, Iowa. Two big delegations of railroad officials, one from Chicago representing the Northwestern and the other from Minneapolis representing the Great Western will be here Friday for a conference with the officials of the Lehigh Portland Cement company, which is to build a plant here this year. F. C. Fiske, chief engineer of the company, arrived this morning and work will begin at once in erecting forty cottages for the employees of the company. Surveys will be made for a mile or more of spurs leading from the two roads. If the roads act quickly in getting the spurs in men such as laborers and artisans will be sent here at once. Five hundred men, says Mr. Fiske, can be used.

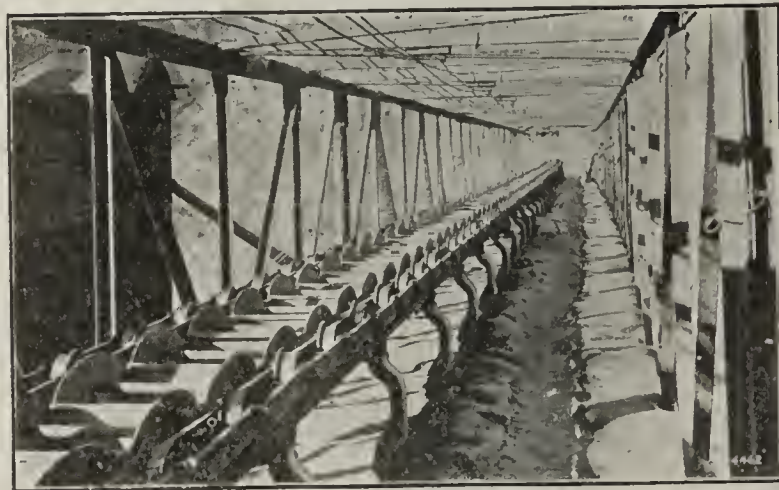
This company utilizes all of its land capable of being farmed. Their barn superintendent will be here soon and will take charge of the growing crops and fruit orchards, which are on the 700 acres of land recently purchased. All the land not spoiled by excavation will be tilled.

PECK CARRIER

fits in with Cement Mill requirements because the wear and tear of this service is confined to a few replaceable wear-resisting parts.

The sprocket wheels and rollers for this work are made of our >FLINT-RIM< iron. Durability at Moderate Cost has been our achievement.

We will send our book No. 81 to any cement man in the country—most have been supplied; but to make sure we would like to hear from anyone who is without a copy.



One of five PECK CARRIERS at the Sandusky Portland Cement Works, Dixon, Ill., to handle clinker, coal and rock.

LINK = BELT COMPANY

PHILADELPHIA

CHICAGO

INDIANAPOLIS

NEW YORK, 299 Broadway

PITTSBURGH, 1501-2 Park Building

ST. LOUIS, Central National Bank Bldg.

SAN FRANCISCO, Eby Machinery Co.

SEATTLE, 439-440 New York Block

DENVER, Lindrooth, Shubart & Co.

NEW ORLEANS, Wilmot Mch. Co.



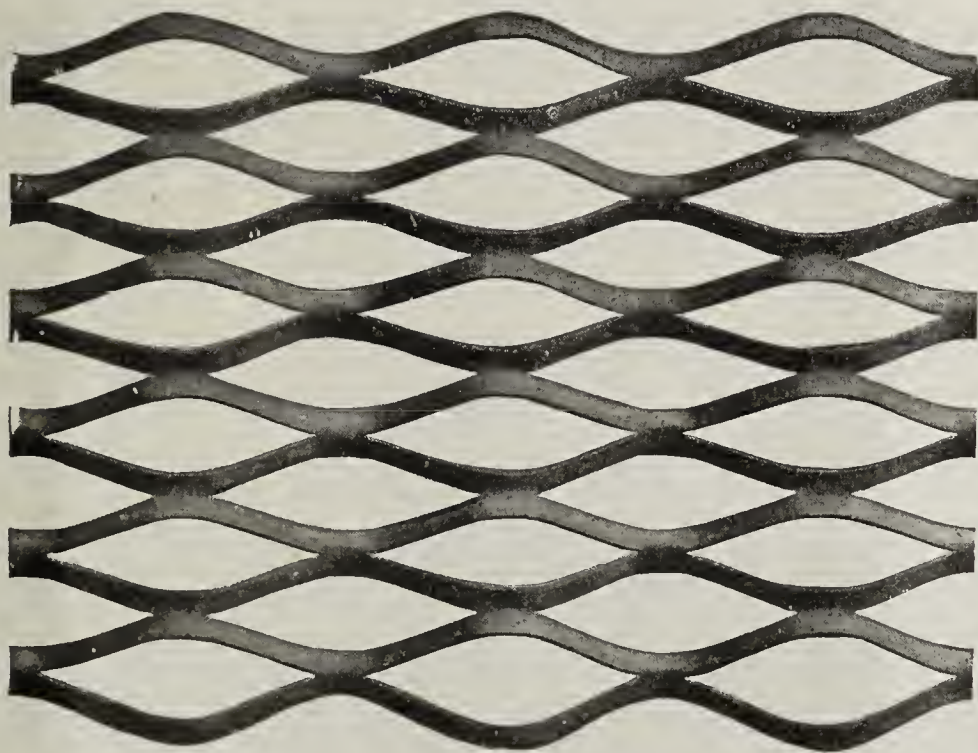
ORENSTEIN-ARTHUR KOPPEL COMPANY

General Offices :
PITTSBURG, PA.

Branch Offices :
New-York Chicago Baltimore

Philadelphia,
304 Stephen Girard Bldg.

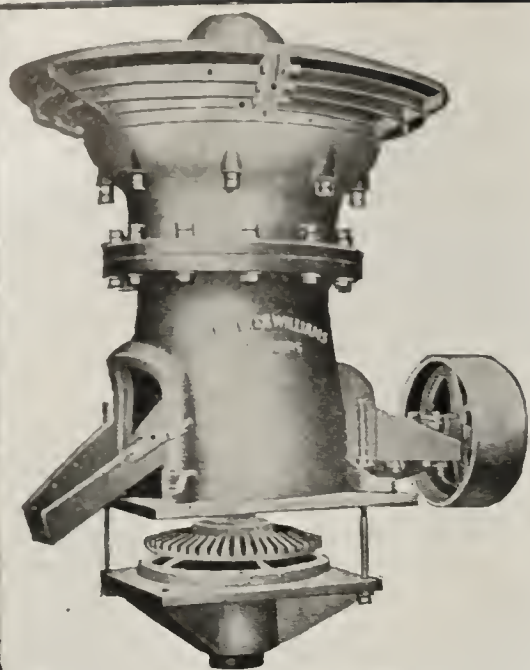
Branch Offices :
Boston San Francisco Denver



BECAUSE of its peculiar formation and self-furring features ---
"Cleveland" Expanded Metal Lath is especially adapted to
exterior stucco work. Write Us for Samples and Prices or Further Information

THE GARRY IRON & STEEL COMPANY

NILES, OHIO



Kennedy Gyratory Crusher

The only Crusher built with a ball and socket eccentric which will lend itself to any change in the inclination of the main shaft. Improved hopper, more efficient dust collars.

— ALSO —

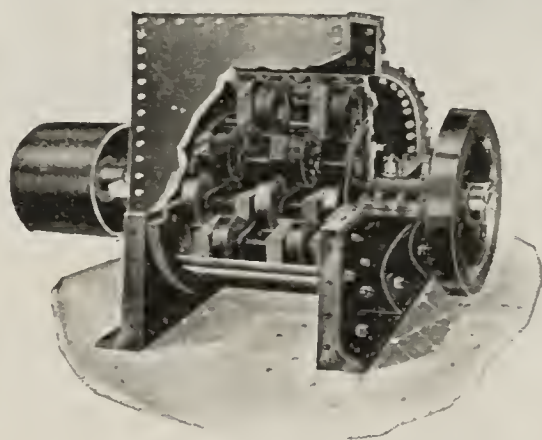
Cement Making Machinery

Kilns, Dryers, Tube Mills, Ball Mills, Elevators, Conveyors, Feeders, Revolving Screens and Crushing Rolls.

Chalmers & Williams Inc.

1927 Commercial National Bank Building, - - - Chicago
120 Liberty Street, New York

American Ring-Hammer Pulverizer



Six Sizes.

will pulverize

Cement, Clinker, Shale, Limestone, Coal, Etc.

30 days' working test at your works allowed. Machines guaranteed.
All Grinding Parts Made of MANGANESE STEEL.

Write for particulars and circulars.

AMERICAN PULVERIZER CO.

410 JACCARD BUILDING

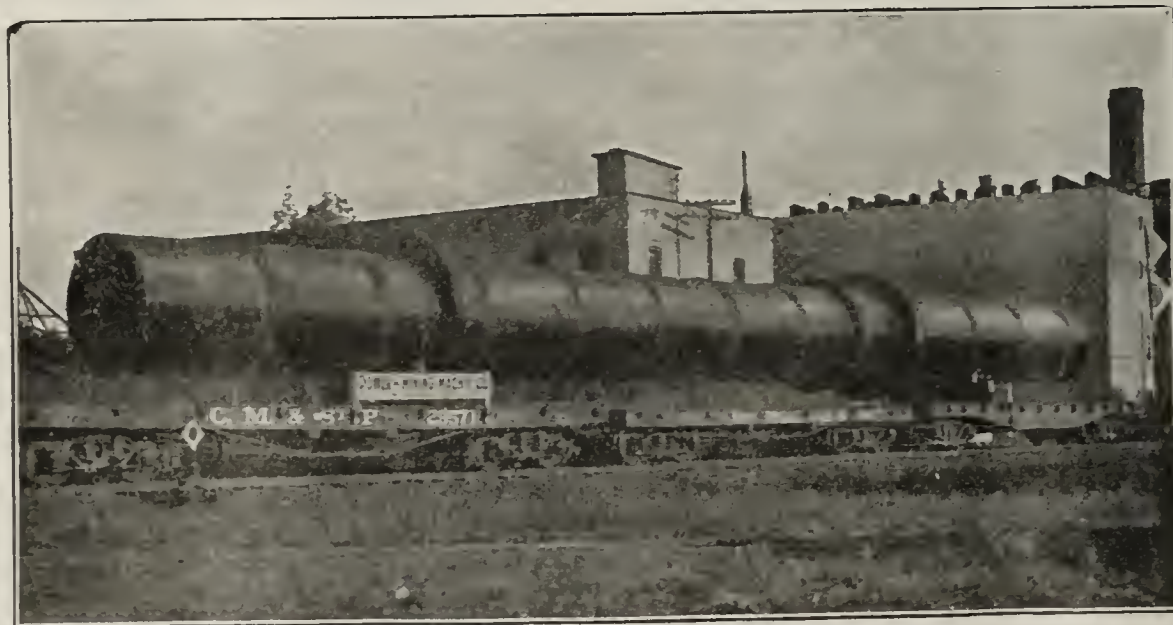


ST. LOUIS, MO.

Cement Mill Machinery

A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process.

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



Write for Catalogue No. 17.

Power & Mining Machinery Company

MILWAUKEE, WIS., U. S. A.

CHICAGO.

NEW YORK.

ATLANTA.

EL PASO.

SAN FRANCISCO.

Allis-Chalmers No. 21 Rock and Ore Breakers

"THE LARGEST BREAKERS EVER BUILT"

These breakers are designed to fill the demand for machines with a large receiving opening and for use in crushing plants producing large quantities of crushed stone. They are proportioned so as to obtain the maximum of strength and rigidity.

Write for Description, Prices, etc.

GENERAL
OFFICES

ALLIS-CHALMERS CO

MILWAUKEE
WISCONSIN

Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - - 645 No. Sixth St., Terre Haute, Ind.

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

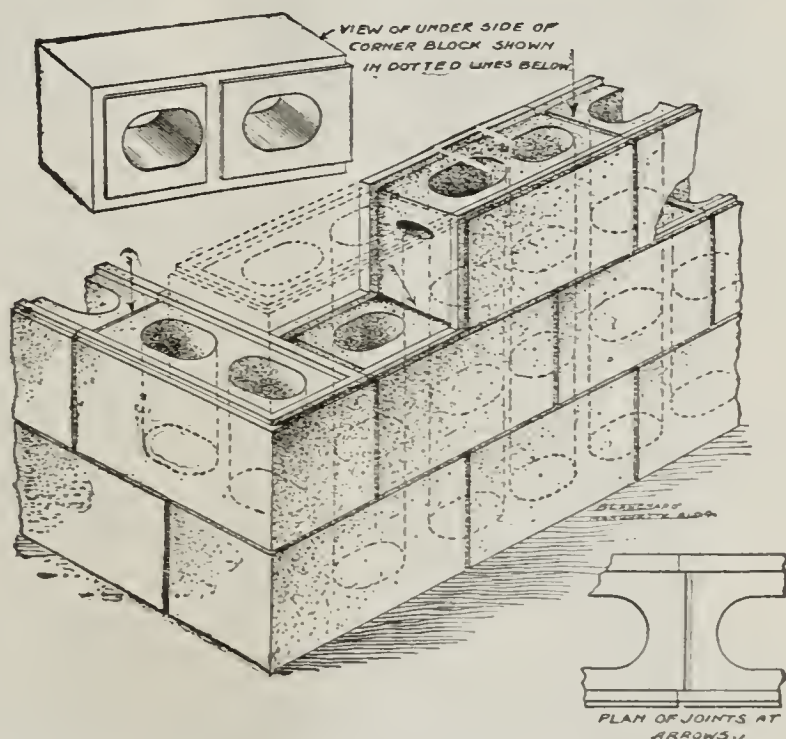
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting
Face-Down Machine by the Wet Process

The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

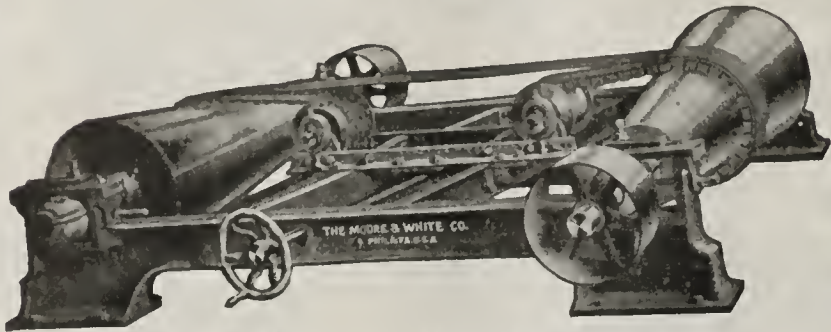
Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and agents wanted in all states and foreign countries.



DIAMOND CONCRETE MACHINERY COMPANY

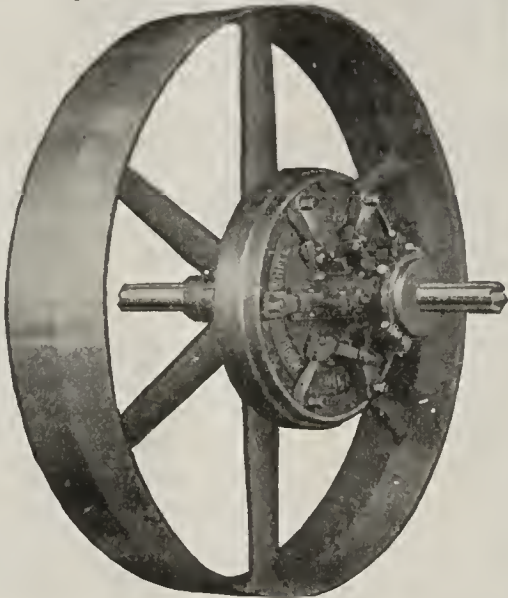
CARDINGTON, OHIO

It will be to any Mill Owner's advantage to investigate these two economical Power devices.



M. & W. Speed Change.

Power
Transmission
Machinery
for
Cement
Mills.



Friction Clutch Pulley.

Write for

Catalogue.

The Moore & White Co.,
Philadelphia, Pa.



Shipping Facilities

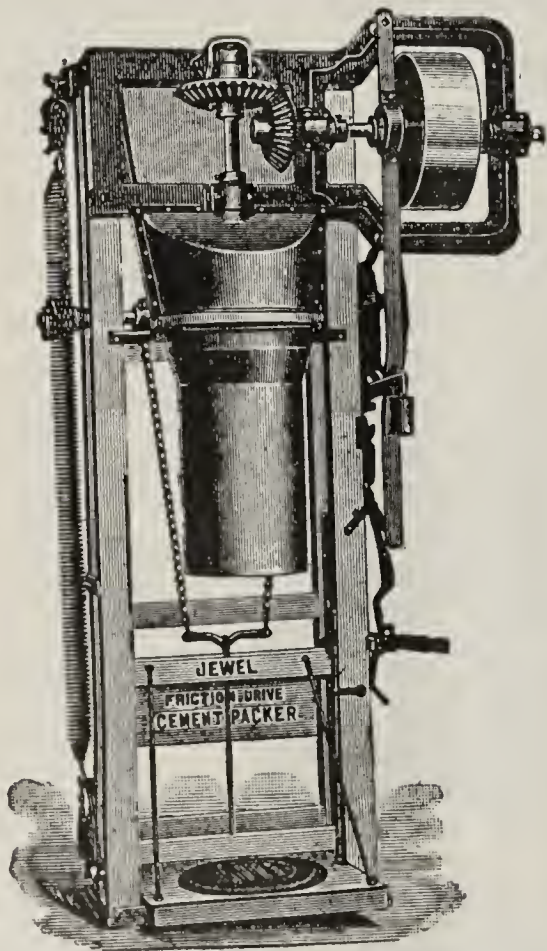
which are unequalled, the strategic location of our plants with reference to freight transportation, our enormous storage capacity, our methods of manufacture which represent the highest development in Portland cement making, the use of the purest and most uniform of raw materials, and our strict compliance with all contracts are the important factors in the growth of our output from 32,000 barrels in 1900 to 8,000,000 barrels in 1910.

Universal Portland Cement Co.

Chicago—Pittsburg

Annual Output 8,000,000 Barrels

There is more Cement being packed by the "S. HOWES" Company's Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and sacks.

The "JEWEL" FRICTION driven cement Packer, specially constructed for rapidly packing sacks.

Both machines are equipped with friction pulleys, heavy iron frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company
SILVER CREEK, N. Y.

Apparatus for Chemical and Physical Testing of Cement

EIMER & AMEND

205-211 Third Avenue, New York City

MANUFACTURERS OF & HEADQUARTERS FOR

Chemical Apparatus, C. P. Chemicals and Reagents

Cement Briquette Moulds.

Gilmore Needle.

Standard Sieves of Exact Meshes.

Williams' Sp. Gr. Balance.

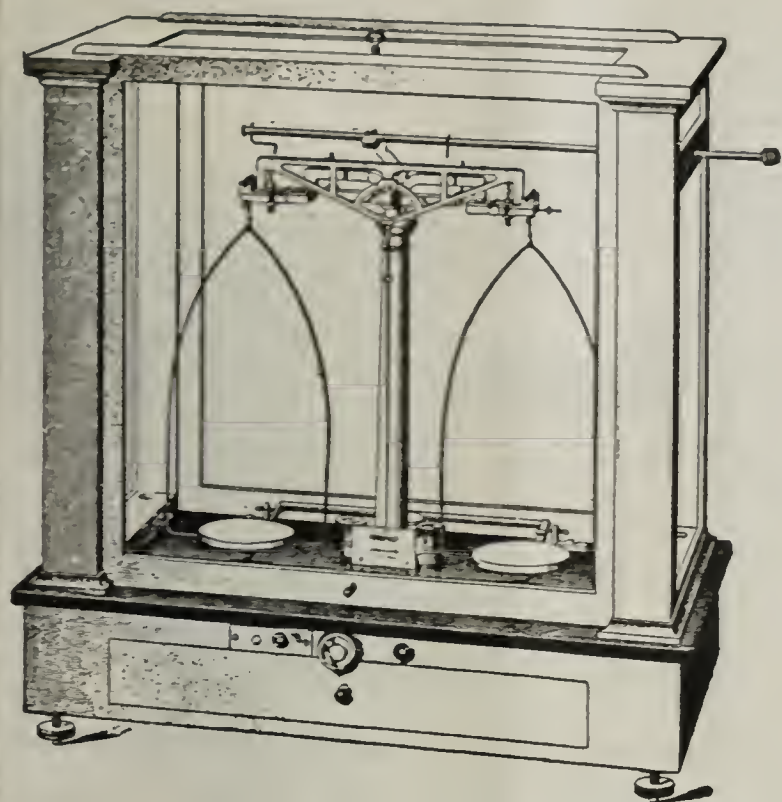
*Specially adapted for determining
Sp. Gr. of Cement.*

(Descriptive Pamphlet sent on request)

*Schumann's, Le Chatelier's,
Jackson's and Candelot's
Apparatus for Sp. Gr. of
Cement.*

Headquarters for **Calorimeters and Pyrometers.**

(Our large illustrated Catalogue gladly sent to Chemists on application.)



F. A. Jones, M. E.

Gypsum Specialist

Consulting Mechanical, and Chemical Engineer, in Designing Construction, and Operation of Plaster Mills, Mines, and Mixing Plants.

Plans, Specifications, Estimates of Cost, Superintendence of Construction, ROTARY or KETTLE PROCESS.

Examination, Tests, Analysis, and Reports of Gypsum Properties, Mills Remodeled and Enlarged, Mixing Plants Erected, and Formulas Furnished.

883 Mahoning Avenue

YOUNGSTOWN, OHIO

WM. B. SCAIFE & SONS CO.

221 First Ave., Pittsburg, Pa.

WE-FU-GO

and **SCAIFE**

Water Softening, Purifying, and Filtering Systems

— FOR —

BOILER FEED

AND EVERY INDUSTRIAL USE.

Send for Complete Information

DEXTER Portland Cement

THE NEW STANDARD

Sole Agents **SAMUEL H. FRENCH & CO.** Philadelphia



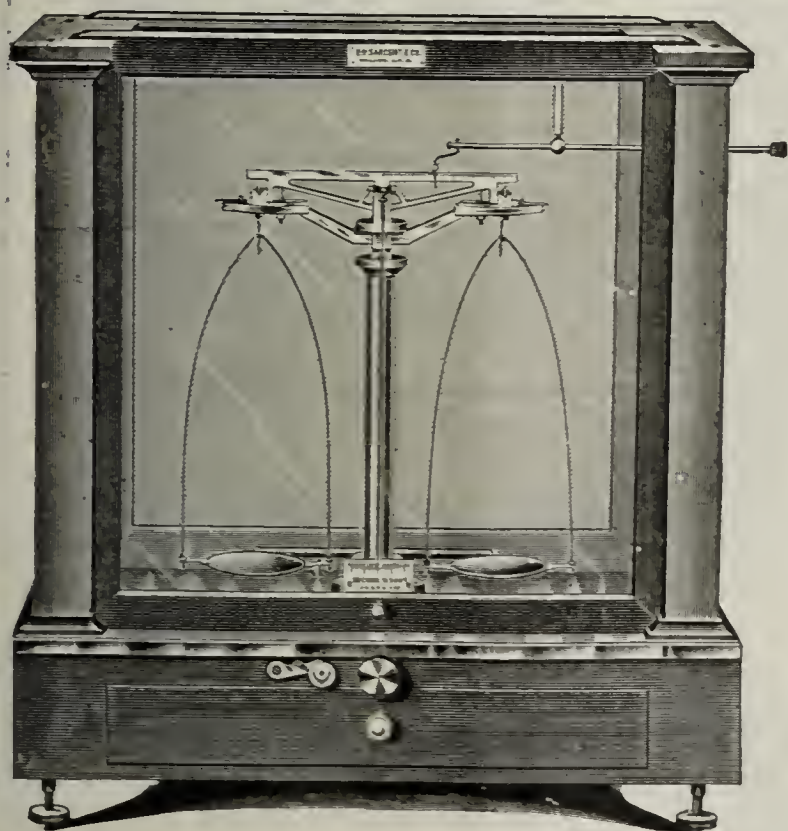
OWL CEMENT

GERMAN AMERICAN
PORTLAND CEMENT WORKS

E. L. COX,

GENERAL SALES AGENT

1527 Marquette Bldg. CHICAGO, ILL.



E. H. SARGENT & CO.

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN

CHEMISTS SUPPLIES

Of high grade only.

We call particular attention to our Cement Mould, Vicat Indenting Apparatus, as improved by us, Gilmore's Needles, Jackson's specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

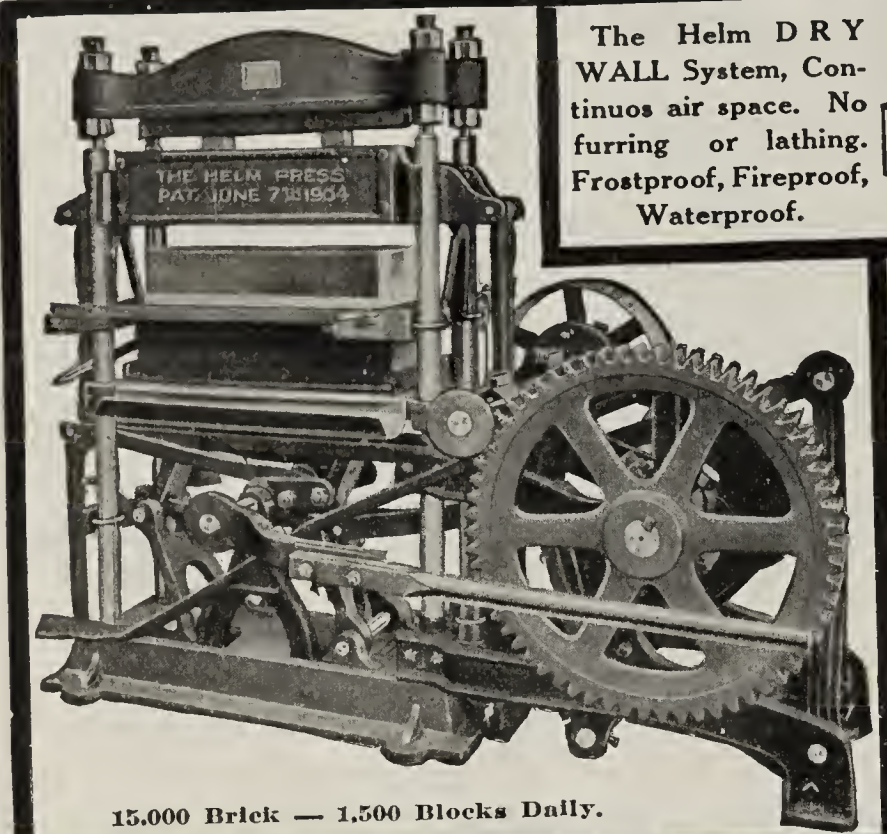
CHICAGO

BIG MONEY FOR YOU

In Pressed DRY-WALL Blocks and Brick

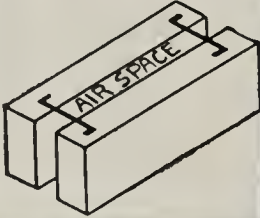
Helm Presses make as high as \$50.00 daily. You can secure the cream of the concrete business with their superior product. Unequalled for beauty, strength, adaptability and cheapness. Daily displacing machines of every description.

The 80,000 lbs. pressure of Helm Brick and Block Presses make the strongest and most uniform concrete product. A 6 to 1 brick only 27 days old stood 85,000 pounds compression, for excelling all other tests. Heavy pressure on medium wet concrete secures this wonderful result with the least cement. A Helm Press and the medium wet mix is the only sure and certain method. You're bound to adopt it in the end. You'll save money by adopting it now. No "extras" to buy with Helm outfits.



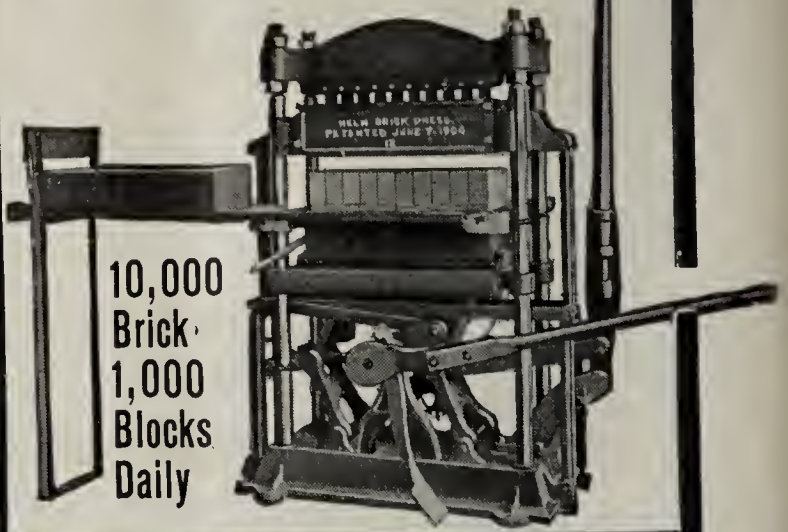
15,000 Brick — 1,500 Blocks Daily.

The Helm DRY WALL System, Continuous air space. No furring or lathing. Frostproof, Fireproof, Waterproof.



80,000 lbs.
Pressure

10,000
Brick
1,000
Blocks
Daily



Investigate the Helm Hand and Power Presses

if you want to control the big contracts in your locality. You can outstrip competition. You can manufacture cheaper, make better product and get better prices and more business.

Send the Coupon for free Concrete Book

Profusely illustrated with half-tones and diagrams of machines, product and building forms. Shows how to secure dry walls. Don't buy without first getting this book. Send the coupon right now for your copy, free and prepaid.

HELM BRICK MACHINE COMPANY,
214 Bank Building, Traverse City, Mich.

HELM BRICK MACHINE COMPANY,
214 Bank Bldg., Traverse City, Mich.

Send me the free book on concrete. Interested in ☐ Blocks, ☐ Brick. ☐ Mixers. ☐

NAME

ADDRESS

Hess Furnaces



No. 45
"Leader" Hess
Steel Furnace
Price \$49.00

Delivered East of Omaha and
North of Ohio River
Pipes and Registers Extra

for the past 7 years, have been sent to customers in every state in the Union, freight prepaid,

On Approval

and the money held back till sixty winter days of actual trial have proved that all our claims for superiority have been fulfilled.

Isn't this worth looking into? Could we offer such liberal terms if we didn't know that the Hess Furnace excels in service, simplicity, efficiency, economy?

All we ask of you, if you need a furnace, is to investigate—to put your name on a postal card, mail to us and ask us for our booklet "Modern Furnace Heating." This booklet is an authority on furnace heating, and copies have been requested by many colleges, libraries, etc., for reference in engineering and mechanical courses. It instructs fully in the principles and practice of furnace heating, and should be in the hands of every builder and house owner. It is free on request.

In Buying Direct

From Our Factory You Pay Only One Profit—A Small, Factory Profit.

Our prices are not inflated with the usual cost for salesmen, branch stores, agents' and dealers' profits. The factory profit only, satisfies us, and you will be surprised at how much we can save you.

Special Heating Plan Free Before You Order

Let us have our experts prepare a special plan for heating your building. It will cost you nothing, and put you under no obligation to buy of us. Our thirty-six years of experience in designing heating equipments makes this free plan valuable to you.

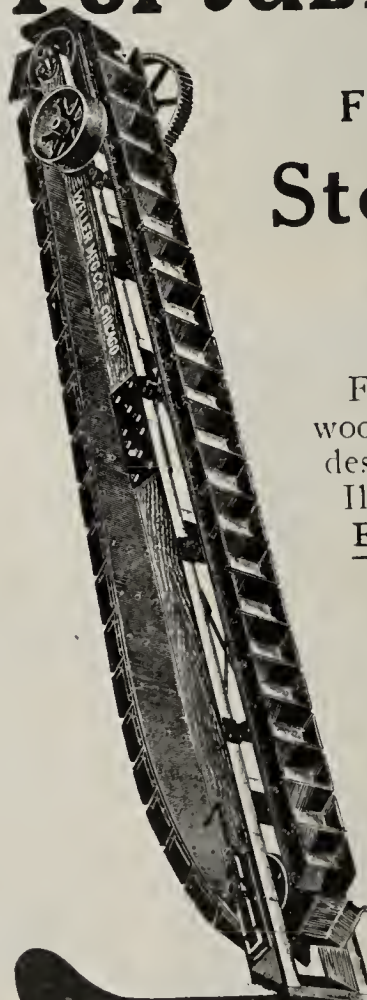
Ask us more about it. A postal card today will serve the purpose.

Hess Warming & Ventilating Co.
919 Tacoma Bldg., Chicago.

Portable Elevators

FOR HANDLING

Stone, Gravel and Cement



Furnished in all designs, with wood or iron frames, and of any desired capacity.

Illustration shows a WELLER-Made Portable crushed stone elevator: we furnish these for handling all classes of materials.

Send for 512 page catalog on WELLER-Made Elevating, Conveying and Power Transmitting Machinery

Weller Mfg. Co.

CHICAGO

WELLER-Made

The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa

GENERAL MANAGER—CEMENT MILL

Executive Officer, formerly with Portland Cement Company, desires connection with operating or organizing company. Experienced in manufacture, sales or finances. Information and references furnished on request. Address M. H. P., 50 Wellington Court, Brooklyn, N. Y.

WANTED.

If you are interested in pumps of latest and best styles, send to us for book and catalogue. Pumps of all styles and for all uses. The Columbus Steam Pump Works, West Broad street, Columbus, Ohio.

WANTED.

—in sixty days—a first class experienced chemist. Two experienced burners. A good superintendent. Address Piedmont Portland Cement & Lime Co., Aragon, Ga.



Medusa White Portland Cement

Used for entire exterior plaster of Ritz Hotel, San Francisco, Cal., here illustrated.

A beautiful product adapted to ornamental artificial stone work of the highest grade. Equal or superior to any other White Portland Cement known.

Write for free sample, pamphlet with instructions for use and price.

MEDUSA WATERPROOFING

(Patented Apr. 23, 1907)

Makes concrete impervious to water and prevents efflorescence and discoloration. Gives absolutely permanent results and does not affect strength, setting or color of Portland Cement.

Used by nearly all the foremost Engineers, Architects, Railways, Contractors, Block Makers and Cement Experts.

Obtain our price and circular, also price on Medusa Gray Portland Cement.

SANDUSKY PORTLAND CEMENT Co., Sandusky, O.



Location for Cement Plant

Extensive Deposits of Raw Material. Proximity to Large and Growing Markets. Low-Priced Fuel Supply.



THERE ARE several desirable locations for Portland Cement Plants along the Santa Fe, where the advantages enumerated are to be found. If you are interested you can secure full and detailed information by addressing this office.

The SANTA FE is glad at all times to co-operate with those seeking locations or desirous of investigating conditions in territory tributary to its line. Correspondence from interested manufacturers is invited.

WESLEY MERRITT, Industrial Commissioner A., T. & S. F. Ry.
1122 Railway Exchange Building CHICAGO, ILL

The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker
1½ inches diameter from the kiln
and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

It saves cost in attention.

MANUFACTURED BY

BRADLEY PULVERIZER CO.

37 Walbrook
LONDON, E. C.

92 State Street
BOSTON



ALPHA

PORTLAND CEMENT....

Alpha, N. J.
Works: Martins Creek, Pa.
Manheim, W. Va.
Alsens, N. Y.

Quality
unexcelled

The Recognized Standard
American Brand

Always
Uniform

ALPHA PORTLAND CEMENT CO.

Manufacturers of but one grade—strictly straight Portland
General Office, EASTON, PA.

JEFFREY SCREENS



Jeffrey Revolving Screen
Two Screening Surfaces, Friction Roller Drive

They are Built in any size suitable for handling any
Material and for making any separations.

Let us know the character of the material to be treated
and we will specify the screen which will give best results.
Our Catalog Aa 69 describes many styles of Jeffrey
Screens mailed interested parties on request. - - - - -

THE JEFFREY MFG. CO.
COLUMBUS, OHIO.

JEFFREY SCREENS
insure satisfactory
results in treating
Sand, Cement, Lime-
stone and all sharp,
gritty materials.

LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GROUND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.,
ALLENTOWN, PA.

Western Office:
725 ROCKEFELLER BUILDING,
CLEVELAND, OHIO.



THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

Design, Construction, Remodeling and Operation
of Portland Cement Plants

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street New York Canadian Express Bldg., Montreal, Can. 1121 The Rookery Chicago 425 Washington St. San Francisco, Cal. Monongahela Bank Bldg. Pittsburgh Syndicate Trust Bldg., St. Louis, Mo. Norfolk House, Cannon St. E. O., London

The Osborn Engineering Co. Civil, Mechanical and Electrical Engineers
Experts in the Designing of
CEMENT PLANTS.
OSBORN BUILDING, CLEVELAND, O.
Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of Cement Machinery

42 NORTH 16TH STREET

:-:

PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

COMMERCE BLDG.,
Kansas City, Mo.

Cement Engineers

Just Out!

Architects' and Engineers' Hand Book on
Reinforced Concrete
Construction

ONLY ONE DOLLAR
CEMENT & ENGINEERING NEWS

22 Fifth Avenue, - - - Chicago

COLONIAL TRUST AND SAVINGS BANK

205 La Salle Street, CHICAGO

Capital and Surplus \$1,100,000.00

We are offering High Grade
Seasoned 5 to 6% Bonds at attrac-
tive prices.

Particulars upon Application



THE IMPROVED DIETRICH'S CLAMP

and

Form System for Hollow Walls

By the use of the Improved
Dietrich's Clamp and Form System
for Hollow Walls the

**COST OF CONCRETE
CONSTRUCTION IS
REDUCED 50%**

and the builder also secures a

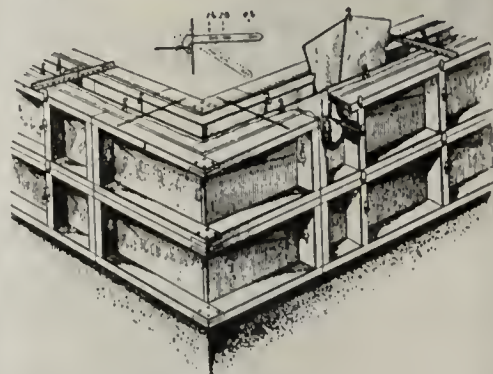
**PERFECT
DAMP-PROOF WALL**

This system is based on the panel
principle and employs removable sheet
iron inner forms with steel iron spacer.
Corners, doors and window openings
are provided for.

Write for pamphlet giving
full information

DIETRICH'S CLAMP CO.

LITTLE FERRY, N. J.



ELEVATING—CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys,
Shafting, Shaft Bearings, Link Belting, Special Chains



HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES.
Catalog for the asking.

SKILLIN & RICHARDS MFG. CO., CHICAGO

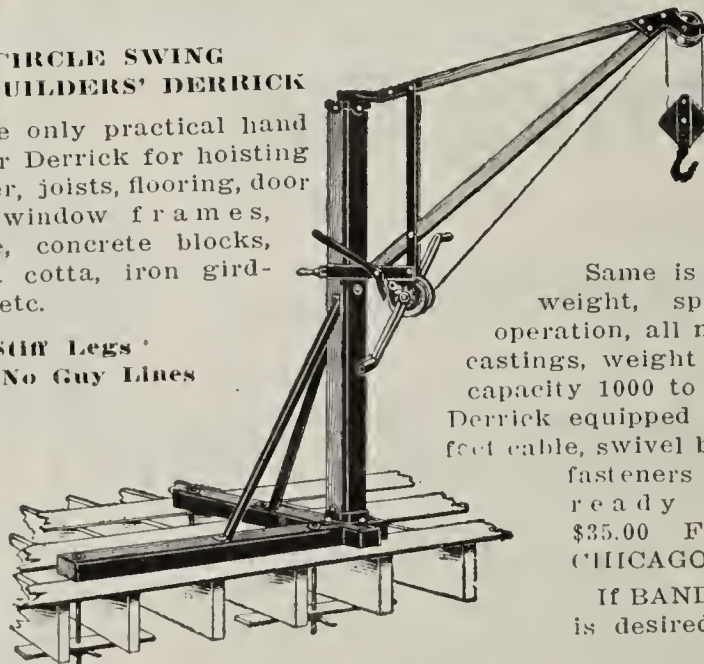
THE SASGEN BUILDERS' DERRICK

The Latest Inventions in
HOISTING APPARATUS

Our CIRCLE SWING BUILDERS' DERRICK

is the only practical hand
power Derrick for hoisting
timber, joists, flooring, door
and window frames,
stone, concrete blocks,
terra cotta, iron gird-
ers, etc.

No Stiff Legs
No Guy Lines



Same is light in
weight, speedy in
operation, all malleable
castings, weight 250 lbs.;
capacity 1000 to 1500 lbs.
Derrick equipped with 110
feet cable, swivel block and
fasteners complete
ready for use,
\$35.00 F. O. B.
CHICAGO.

If BAND BRAKE
is desired, add \$1

We keep all these machines in stock and can fill orders promptly.

SASGEN BROS.

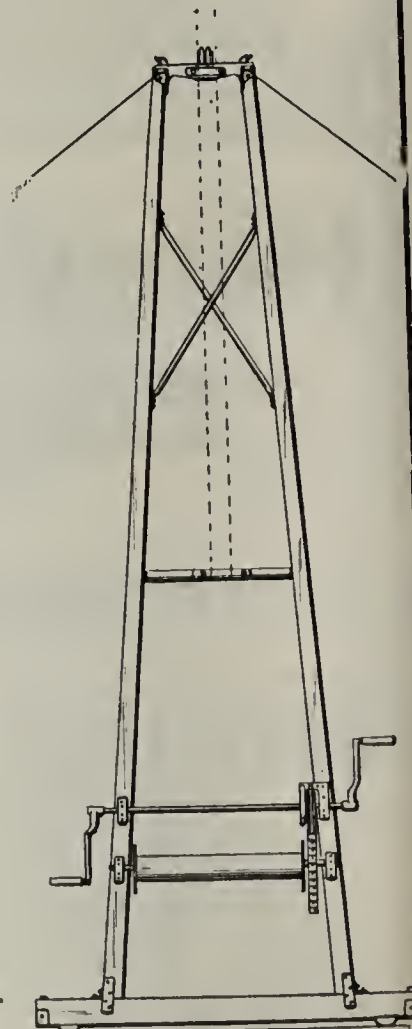
2053-57 Racine Ave., - - - CHICAGO, ILL.

New York Office, 103 Park Ave.

Write for Illustrated Catalogue "C"



OUR POLE DERRICK is built
light and strong. Average length
18 ft.; weight 200 lbs.; capacity
1800 lbs.; equipped with 100 ft.
cable block and rollers ready for
use \$26.50 F. O. B. Chicago.



OUR SASGEN IMPROVED
SETTER DERRICK in-
cluding a top shive frame,
extension clamps, etc
Price of 20 ft. lengths
\$42.00 F. O. B. Chicago.

NEW BOOKS

The Manufacture of Hydraulic Gypsum and Other
Gypsum Products - - - - - 50 Cents

By M. Glasenapp

The Hardening Process of Hydraulic Cement }
The Hardening of Cement Under Water } - 50 Cents Each
The Constitution of Hydraulic Cements }

By Dr. W. Michaelis, Sr.

How to Use Portland Cement - - - - - 50 Cents
Cement Sidewalk Construction - - - - - 50 Cents
Hollow Concrete Building Block Construction - - - 50 Cents
Monier Cement and Steel Construction - - - - - 50 Cents
Handbook of Reinforced Concrete Construction, paper cover 50 Cents

By L. J. Mensch

Delivered Free on Receipt of Price.

Address CEMENT & ENGINEERING NEWS
22 Fifth Avenue, Chicago

JUST A REMINDER

ATLAS DRYERS—DRY NEARLY EVERYTHING

THE ATLAS DRYER CO., CLEVELAND, OHIO

"EXPENSES DIMINISHED"

"MEANS PROFITS INCREASED"



A CAREFUL COMPARISON OF OUR
STOCK AND PRICES WILL DEMON-
STRATE A SAVING TO YOU OF FROM
30 to 75%.

SEND YOUR INQUIRY TO-DAY.

ROCK CRUSHERS.

1—9 x 15 Allis Chalmers Jaw Crusher.

ROCK DRILLS.

6—Ingersoll-Sargeant Rock Drills, size
3 1/4 inches.

6—Ingersoll-Sargeant Rock Drills, size
3 1/2 inches.
Fitted for steam or air.

HOISTING ENGINES.

1—12x16 double cylinder, heavy duty
LIDGERWOOD hoisting engine.

1—6x8 Marine Iron Works double cy-
linder, single drums, reversible in
steam chest.

PUMPS.

3—24 inch Centrifugal pumps, 2 to
3,000,000 gallons capacity.

1—20x13x12 Wheeler & Tappan Duplex
Pump.

IRON PIPE.

70,000 ft. 1 inch Standard Pipe, 35,000
ft. 1 1/4 inch Casing.

50,000 ft. 1 1/2 inch Standard Pipe, 40,000
ft. 3 3/4 inch Casing.

30,000 ft. 2 inch Standard Pipe, 60,000
ft. 3 3/4 inch Casing.

2,000 ft. 10 inch Standard Pipe, 8,000
ft. 5 5/8 inch Casing.

4,000 ft. 12 inch Standard Pipe, 3,000
ft. 6 1/4 inch Casing.

30,000 ft. 8 inch Cast Iron Pipe, 1,000
ft. 6 5/8 inch Casing.

300 ft. 24 inch Cast Iron Pipe, 1,250
ft. 8 3/4 inch Casing.

1,500 ft. Riveted Steel Pipe, 24 inch to
72 inch diameter.

ROOFING MATERIAL.

The latest and most modern product
ever offered to the public. Our "Raw
Hide Rubber Roofing" is without equal
in durability and price. Will outlast the
kind you have been using from 10 to 15
years and will cost you less. Is fire and
weather proof. Send for our special book
No. 180 on roofing; tells you all about it.

TANKS.

12—1,000 gallon capacity tanks.

42—1,500 gallon capacity tanks.

6—3,000 gallon capacity tanks.

15—3,600 gallon capacity tanks.

2—3,800 gallon capacity tanks.

STEEL STORAGE TANKS.

Capacity, 4,500 to 6,500 gallons. These
tanks were used only a short time in
railroad service. Very heavy construc-
tion—1/4" steel with 5-16" heads; domes in
proportion to size of tank, and fitted with
15" screwed manhole. We will give
them rigid inspection and paint before
shipment. Prompt shipment can be made
from points South, East and West.

5,000 rolls rubber, leather and canvas belting, structural iron, shafting, pulleys, couplings, steel wire and manila rope. Smoke
stacks, corrugated roofing and siding, hose hydrants, tanks. We can save you money on anything you require.

SEND FOR OUR NEW 500-PAGE CATALOG NO. 962.

A wonderful book of facts and information of the utmost value to everyone. Send to-day. It will cost you nothing.

CHICAGO HOUSE WRECKING CO., 35th and Iron Sts., CHICAGO, ILL.



Dolese & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world.
Machinery throughout installed by us.

OLSON BROS. & CO.

Engineers and Contractors

Cement Mill Machinery Erected, Stone Crushing
Plants Equipped and Erected. :: :: :: ::

ALSO COMPLETE PLANTS FOR HANDLING
COAL, SAND, GRAVEL, ORES, ASHES, ETC.

MODERN POWER TRANSMISSION
Elevating and Conveying Machinery.

Tanks and Vats, Especially in Connection with Machinery

2418-22 Bloomingdale Ave., Chicago



TRADE MARK

PENINSULAR PORTLAND CEMENT

Acknowledged by competent Architects and Engineers
to be unequalled for fineness, wonderful development
of strength and sand carrying capacity.

"THE BEST IS THE CHEAPEST"

Address

Peninsular Portland Cement Co.
JACKSON, MICHIGAN.

SPECIFY

Tisco Manganese Steel

FOR

Ball and Tube Mill Linings,
Gears, Pinions, Sprockets, Chain

IT LASTS LONGEST

TAYLOR IRON & STEEL CO.
HIGH BRIDGE NEW JERSEY

Peerless Portland Cement

MANUFACTURED AT UNION
CITY, MICH.

**Every Barrel
Guaranteed**

Fineness, Uniformity of Color
and Sand Carrying Qualities
equal to any Portland Ce-
ment Manufactured

Iron-Ore Cement

The only reliable cement for marine
construction.

A cement which resists sea water
and is proof against refuse water
of mines and all liquids contain-
ing sulphates.

Manufactured on strictly scientific
principles.

Iron-Ore Cement is used exclusively
by the German Government in
place of Portland cement for all
Marine Construction.

Send for Literature, Etc.

WORM-COX COMPANY
SOLE AGENTS

Marquette Building, Chicago

MEACHAM & WRIGHT CO.

Sales Agents

IMPROVED

UTICA HYDRAULIC CEMENT

And Dealers in

LEHIGH PORTLAND CEMENT

Telephone 206 La Salle St. Chicago
Main 59

F. D. MEACHAM, Pres.
S. P. BLOUNT, Treas.

F. S. WRIGHT, Vice-Pres.
C. M. FOSTER, Secy.

Improved Canvas Stitched Belting



We Specialize in making Belts
for use in Cement Plants.

Light or Heavy Transmission,
Elevator or Conveyor Belts for
Wet, Dry, Hot or Rough condi-
tions.

Sawyer Belting Co.

Cleveland, O.

Send for Book "K."



"PRESENT"

Elastic Limit 64,000 lbs.
per sq. in.

Bends double **cold** with-
out fracture.

CALL THE ROLL

of famous concrete structures and in the most important buildings you will find the M-B Bar "Present." At the bottom of this page you will find a few examples of the class of buildings in which the M-B Bar is specified and used by leading engineers and architects.

It is highly significant that some of the most notable achievements in reinforced concrete construction have been accomplished with M-B Bar Reinforcement.

Two world's records in reinforced concrete construction were achieved with our

M/B Special Open Hearth Bar (Cold Twisted) FOR REINFORCING CONCRETE

The world's largest all-reinforced concrete building of any kind is the Montgomery Ward Building, Chicago, which is reinforced exclusively with M-B Bars.

The world's largest all-reinforced concrete office building is the new Plymouth Building, Minneapolis, which is reinforced exclusively with M-B Bars. This building is 15 stories and all concrete—columns, beams, slabs, and wall spandrels all concrete and reinforced with M-B Bars. It is 202 feet, 6 inches high and has 480,000 square feet of floor area, being in these two respects the largest office building ever built with all-reinforced construction throughout.

As compared with structural-steel-hollow-tile construction, the owners saved **One Hundred Thousand Dollars** by using concrete construction exclusively and reinforcing with M-B Bars.

That a certain bar is used in an ordinary building does not mean much, but when an engineer or architect is about to attempt that which has never before been accomplished in reinforced concrete construction, it stands to reason that he will select the kind of reinforcement that is most certain to stand the supreme test; and that the M-B Bar was so specified and used in the Montgomery Ward Building and the Plymouth Building is the strongest possible endorsement of this particular reinforcing material.

Now, when history repeats itself time, time and again, and you find the M-B Bar used in the big buildings, the notable structures in all parts of the country, it certainly is an indication that the M-B Bar possesses **merits** which entitle it to such preference and prominence.

The M-B Bar is a **superior** steel, rolled from new billet stock and **twisted cold**. With an elastic limit of approximately 60,000 lbs. per square inch, it can be **bent double cold** without fracture.

It is the only bar which **combines High Elastic Limit and great ductility**.

It possesses the **great strength** of high-carbon steel **without its brittleness**, and the **great ductility** of low-carbon steel without its excess weight and cost. It is the only **steel** which makes it possible to secure economy of design **consistent with absolute safety**. M-B Bars are the **safest** and the **cheapest** known reinforcement for concrete.

"The Bar That Never Failed"

Our new book—"The Bar That Never Failed"—is just off the press. It contains concrete data and formulæ valuable to any engineer or architect and gives convincing reasons why the M-B Bar is the most economical and **reliable** steel for reinforcing concrete. Send for a copy—mailed free on request.

William B. Hough Company

"Where the Reliable Reinforcing Steel Comes From"

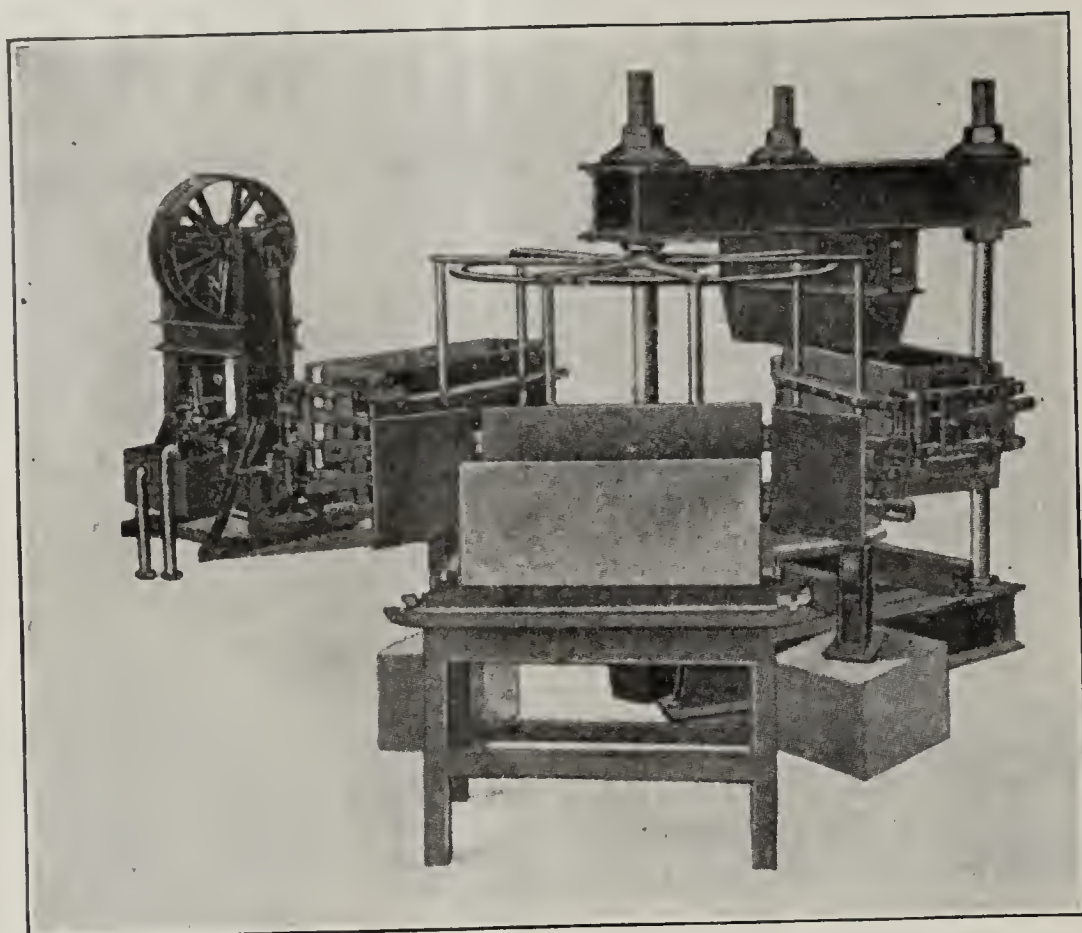
HOME OFFICE: CHICAGO, U. S. A.

Detroit — Minneapolis — Indianapolis — Des Moines

Montgomery Ward Building, Chicago.
Sears Roebuck & Co.'s Printing Building, Chicago.
Bee Building Annex, Omaha, Nebr.
Helen Realty Co.'s Hotel and Theatre Bldg., Indianapolis.
McFadden Coffee & Spice Co.'s Warehouse, Dubuque, Iowa.
Citizens Bank Building, Bedford, Iowa.
C. R. I. & P. Ry. Depot, Esterville, Iowa; Freight House, Cedar Rapids, Iowa; Laundry and Commissary Building, Rock Island, Ill.
The Plymouth Building, Minneapolis, Minn.
Healy Building, Detroit, Michigan.
Blackstone Theatre, Chicago.
American Seeding Machine Company, Richmond, Indiana.
Ed. Schuster & Co.'s Building, Milwaukee, Wis.
The Firestone Tire & Rubber Co.'s new plant, Akron, O.
The Liquid Carbonic Co.'s huge new plant, Chicago.

Washington Street Tunnel for Chicago subway.
La Salle Street Tunnel for Chicago Subway.
General Motor Co.'s Buildings at various points in Mich.
Salt Lake & Ogden Ry. Co.'s Bridges at Salt Lake City and Ogden, Utah.
Detroit Water Works Reservoir and Power Plant.
City Reservoir, Shawnee, Okla.
Terre Haute Trust Co.'s Building, Terre Haute, Ind.
Francis Perot & Sons' Grain Elevator, Buffalo, N. Y.
Corn Products Terminal Co.'s Plant, Granite City, Ill.
Big Four Railway Beech Grove Shops, Beech Grove, Ind.
I. N. Peyton Building, Spokane, Washington.
United States Circuit Court Building, Jefferson City, Mo.
Mar del Mobile Co.'s Garages, Baltimore, Md.
And hundreds of others.

A DENSE CONCRETE



A Hydraulic Ram Pounding Concrete Into Blocks

TWO MEN do the work. From 1000 to 2000 blocks per day. Three quick-acting mold boxes rotating over the Ram on a Revolving Table, one being filled, one receiving the pounding, one delivering the finished block.

The Fisher Hydraulic Machine pounds a wet mixed mortar together with a Hydraulic Ram and produces a dense concrete with less than 5% absorption, with a high crushing strength, in any style to suit the demand.

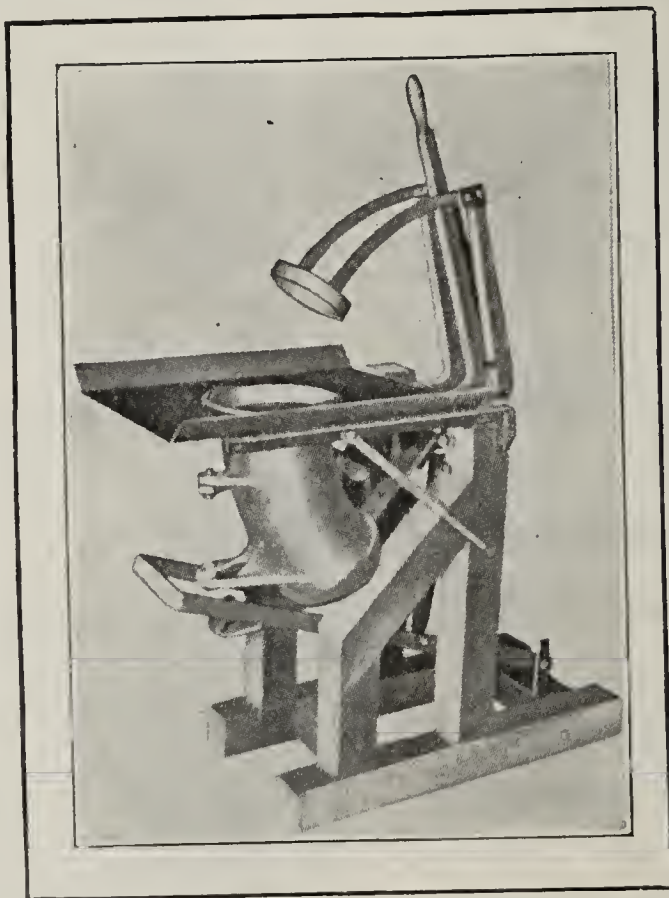
Ask for Catalogue or any information regarding our system.

Fisher Hydraulic Stone & Machinery Co.
MOUNT GILEAD, OHIO.

Concrete Sewer Pipe Bends

The Only Machine
of Its Kind
on the Market.

Concrete Sewer Pipe
Bends Made on the
**RICKMAN SEWER PIPE
BEND MACHINE** Make
Money for the Manu-
facturer.



The Latest Thing
Added to the Concrete
Machinery Line.

ONE MAN can make from 15 to 20 curved sections of pipe per hour. Shovel in the material, tamp it with the tamping ring, operated by foot lever, attach the bell-end form, complete the section, withdraw core from below, by lever, carry the pipe away to a pallet and bring the outer mold back to the machine.

You Need This Machine to Complete the Equipment of Your Tile Factory

Write for Circulars and Prices

R. L. RICKMAN CO.,

987 Westminster Avenue,
VANCOUVER, B. C.

POSTAL TELEGRAPH - COMMERCIAL CABLES	
DELIVERY NO. <i>Dg</i>	CLARENCE M. MACKAY, PRESIDENT.
CABLEGRAM	
RECEIVED AT 20 BROAD ST., N. Y.	
The Postal Telegraph-Cable Company (Incorporated) transmits and delivers this cablegram subject to the terms and conditions printed on the back of this form.	

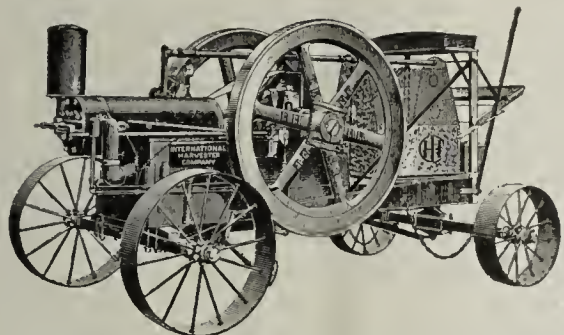
DESIGN PATENT APPLIED FOR

(Western Union Code)

A complete success. Present prospects indicate additional new works.

No inquiry respecting this message can be attended to without the production of this paper. Repetitions of doubtful words should be obtained through the Company's offices and not by DIRECT application to the sender.

International Sand-Lime Brick & Machinery Co., 90 WEST STREET
New York City



Chicago U S A

COPYRIGHTED BY E. I. DU PONT DE NEMOURS POWDER COMPANY, 1940

SELECTED WHITE SAND

For.

Ornamental
Concrete
Stone



Cement
Block
Facing

For.

Hard
Plaster
Finishing

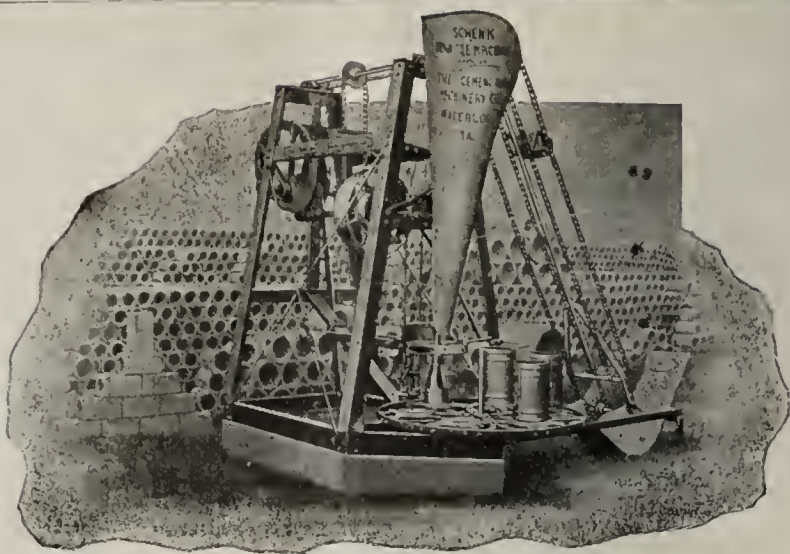
Exterior
Plastering

Stone & Marble Sawing

Shipped in paper lined box cars or 150 lb. bags

UNITED STATES SILICA CO.

1041 AMERICAN TRUST BLDG.
CHICAGO



The Schenk Cement Drain Tile Machine

is conceded by all who are familiar with the concrete machinery business to be absolutely the most perfect and the most successful machine in the field; upon its merits the cement drain tile industry has been built; and on account of its success other machines have been constructed, but no machine at the present date surpasses the Schenk Machine for capacity, durability, convenience, economical operation and for satisfaction.

We sell the Schenk on an Iron Clad Guarantee, backed by the largest exclusive concrete machinery manufacturers in the world.

Our free catalog, "Money in Cement Tile" will give you interesting information relative to the proper equipment, the construction of buildings the amount of capital required, the amount of profit to be expected; in fact, it tells how to start a plant for the manufacture of cement drain tile and just what you will be able to realize on your investment.

Write for it today.

The Cement Tile Machinery Co.
WATERLOO, IOWA

Face Your Blocks

Do You
Use

WHITE SAND

Leading contractors specify our pure White, Washed and Screened Silica Sand for fine work in ornamental stone, block facing, porch work, ornamental lawn fixtures, vases, etc.
This sand is shipped both DRY and DAMP.
Prices and Samples on request.

BALLOU'S WHITE SAND COMPANY
MILLINGTON, ILLINOIS

Make Them White

**IT WILL PAY YOU
TO USE**

CROWN HYDRATE

(HIGH CALCIUM HYDRATED LIME)

For Waterproofing and Concrete

It Improves Its Strength and Color. Ask the

Marblehead Lime Company

KANSAS CITY

CHICAGO

When You Sit Down To Figure The Dollars Saved In A Concrete Mixer

IT'S not the first cost that's important but how soon the investment has been returned.

—There's the up-keep, the quantity produced, the quality of mixing and the saving in the pay roll when pay day comes.

—Quality in a mixer pays dividends when initial cost is forgotten.

But it costs just as much to build a mixer embodying the ideas in mixing of 5 or 10 years ago as it does the best mixing practice now.

Its not what you pay but what you buy that counts.

Here's an epitome of the fulfillment of present day mixing you buy in the

Koehring Concrete Mixer

The heaviest drum on any mixer—greatest strength in the most important wearing part.
Three independent, positive mixings in the one drum—most rapid mixer made.

Trunnion rollers placed close to ends to give drum great stability.

Rollers cast with broad faces and chilled as hard as tempered steel.

Double-gear drive close to ends equalizing uneven strains.

Charged direct from barrows on a level with the ground.

No elevated runways of any kind required.

Simplest charging elevator on any mixer.

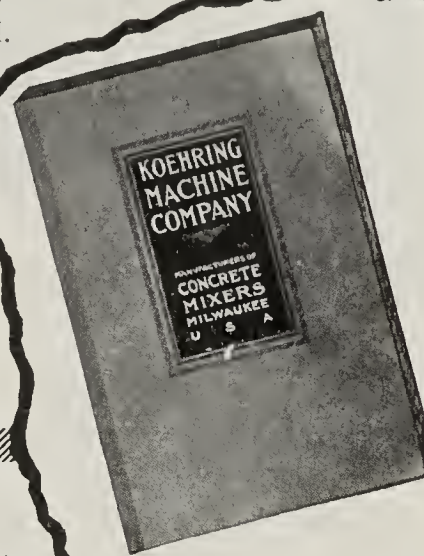
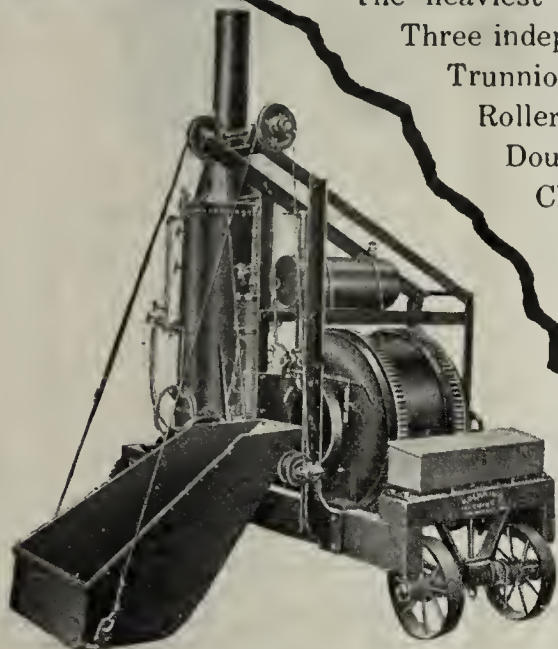
Discharge chute does not interfere with barrows.

Discharge always under perfect control.

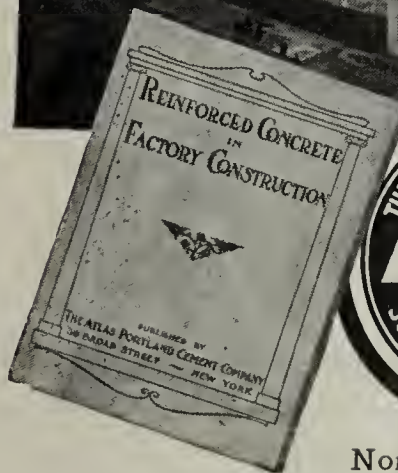
Discharges by simply raising inner end of chute.

Equipped with steam, gasoline or electric power.

A card will fetch the catalog: mention "Catalog B."



Koehring Machine Co.
614-616 Germania Bldg., Milwaukee, Wis., U. S. A.



None Just As Good

The book, "REINFORCED CONCRETE IN FACTORY CONSTRUCTION," will be sent for 10c. It illustrates and describes many different types of factories built of concrete. It demonstrates the economy, safety, convenience and adaptability of concrete for all factory purposes.

Other books in the Atlas Cement Library:

Concrete Houses and Cottages Vol. I. Large Houses \$1.00

Vol. II. Small Houses 1.00

Concrete Construction about the Home and on the Farm, Free

Concrete in Highway Construction 1.00

Concrete in Railroad Construction 1.00

Concrete Cottages, Free Concrete Garages, Free

If your dealer cannot supply you with Atlas, write to

THE ATLAS PORTLAND CEMENT COMPANY
DEPT. D. 30 BROAD STREET, N. Y.

Largest productive capacity of any cement company in the world. Over 50,000 barrels per day.

Hotel Cumberland

NEW YORK

S.W. Cor. Broadway and 54th St.

Near 50th Street Subway Station and 53d Street Elevated

HEADQUARTERS FOR THE CEMENT
AND MACHINERY MEN.

New Modern Fire Proof

All Outside Rooms. No Carpets. All Oriental Rugs.

Transient Rates \$2.50 with Bath and up.

10 minutes walk to 20 theatres.

Send for Booklet.

HARRY P. SIMPSON, Formerly with Hotel Imperial.

R. J. BINGHAM, Formerly with Hotel Woodward

CHARLES F. McKENNA, Ph.D.

Inspection of Cement

and all other Engineering Materials. Examination of Properties and of Economical Operation of Works.

Consulting and General Practice in
Chemistry, Technology, Chemical
Engineering and Chemo-
Legal Cases.

Long Distance Telephone.

Cable Address: PLAT PEARL

Laboratories: 221 Pearl St., New York City

Offices: 50 Church Street

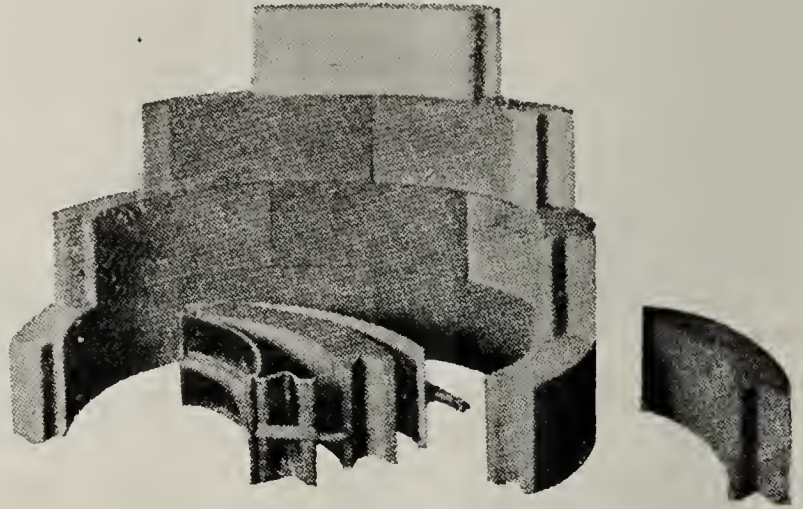
THE PERFECT BRICK MACHINE THE PERFECT CISTERN AND SILO MOLDS

ARE USED IN ALL PARTS OF THE WORLD

OUR MOLDS are the BEST and CHEAPEST ever offered to the public



THE PERFECT is the Simplest, Easiest, Fastest, Most Durable, and is operated with less labor than any other brick machine, therefore yielding more profits to the manufacturer. If you are looking for the latest improved and up-to-date invention you will make no mistake in purchasing the PERFECT.



The Perfect Well, Cistern and Silo Mold.

HERE IS OUR PRICE LIST

No. 3 Circle Mold is 3 ft. diam.	No. 10 Circle Mold is 10 ft. diam.
" 5 " " 5 ft. "	" 12 " " 12 ft. "
" 7 " " 7 ft. "	" 14 " " 14 ft. "
	" 16 " " 16 ft. "

All sizes up to 7 foot retail at \$12.00 each.

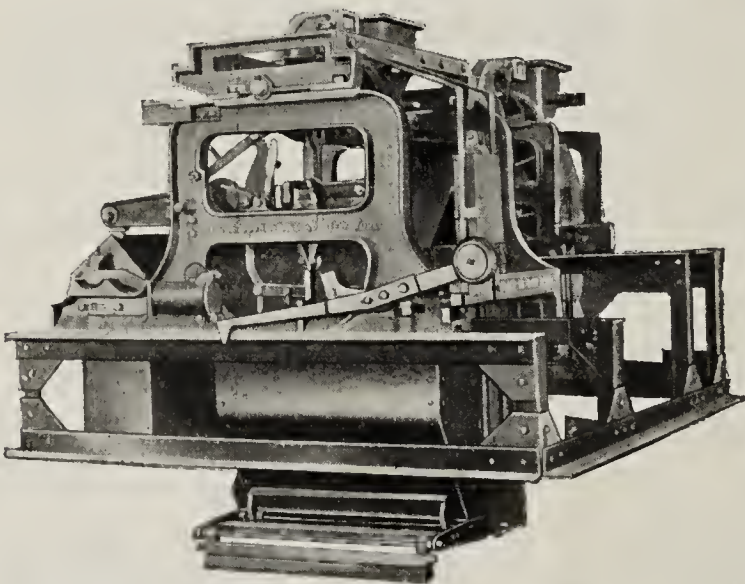
All other sizes retail at \$15.00 each.

The Circle Molds vary in length from 22 to 28 inches, depending upon the diameter of its circumference.

In ordering Circle Molds always give the diameter of what you are going to build and I will then understand the kind of a circle mold you desire.

C. S. WERT, 602 North Main Street, Kendallville, Indiana, U.S.A.

TO MAKE THE BEST CEMENT, USE Richardson's Automatic Proportioning Scales



Two or more scales yoked together with our Electric Discharge Mechanism will weigh Crushed Raw Materials direct from bins with perfect accuracy and discharge simultaneously.

These machines fitted with our Conveyor Feed will also weigh Pulverized Materials direct from bins.

Greatest Possible Range of Weights. Exact Proportions Absolutely Guaranteed. Continuous Uninterrupted Operation.

Similar Machines for Clinker and Gypsum. Automatic Hopper Scales for weighing Cement to Stock Bins. Automatic Bagging Scales for Finished Cement. Speedy and most accurate yet devised.

Write for particulars to

RICHARDSON SCALE COMPANY

16 Park Row, NEW YORK 122 Monroe St., CHICAGO

Ball Mould \$2.55

Attractive Draws Easily Sells Readily

Ornamental Moulds Bring Good Profits at any Time of the Year



WHOLESALE CATALOG.

Send for Big Wholesale Catalog. It is an encyclopedia of what you ought to have and at prices you ought to pay.

Send for it today. It lists everything.

Northwestern Steel & Iron Works

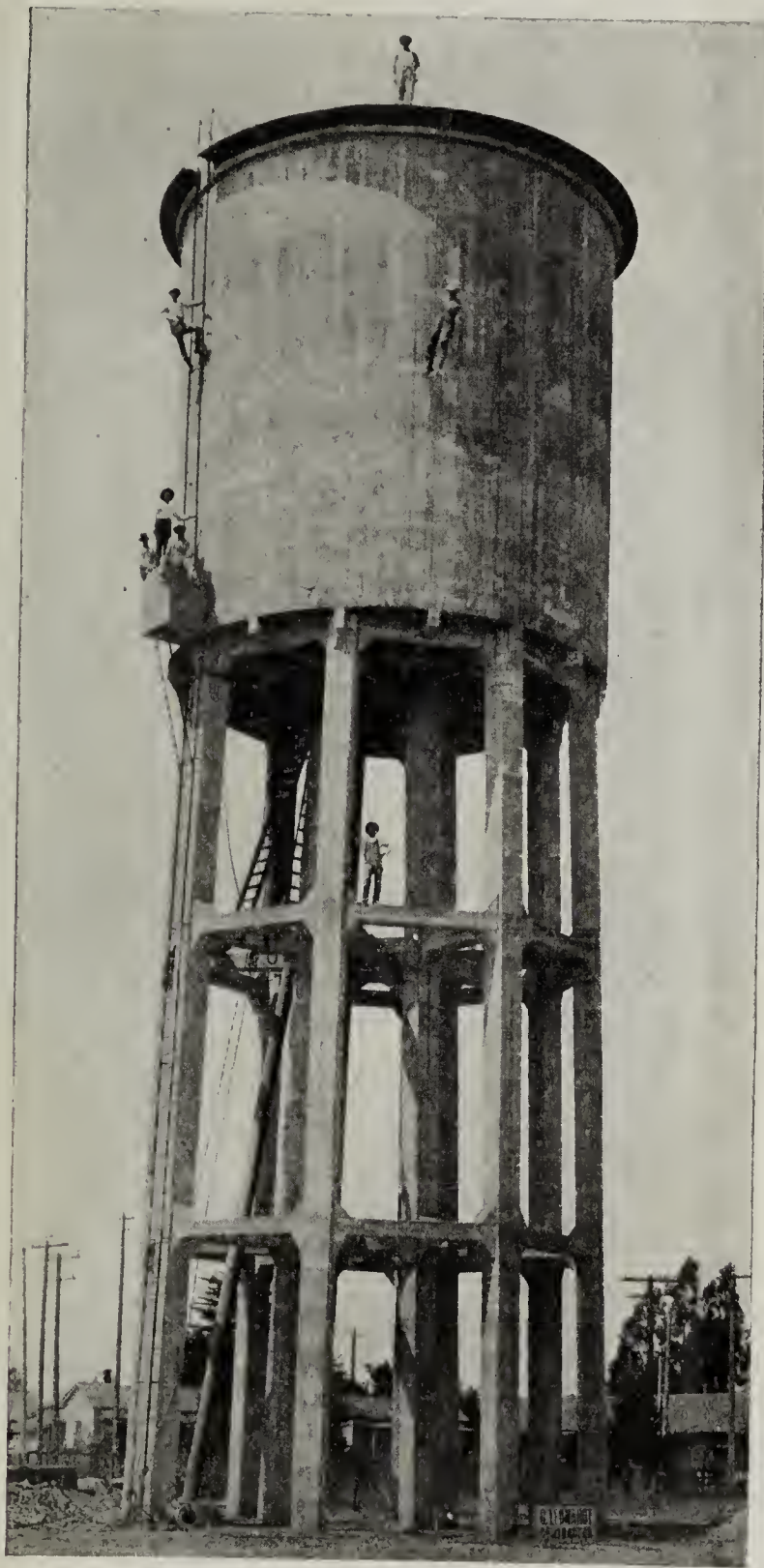
EAU CLAIRE, WIS.

BOX 844

CEMENT

... AND ...

ENGINEERING NEWS



View of the Anaheim Water Tower built for the Anaheim Water Company, at Anaheim, California; Mr. C. Leonhardt, of Los Angeles, California, contractor. This is not only a water tower, but a reinforced concrete tank. Some idea of the magnitude of the work can be had when we consider that the extreme top of the tank is 112 feet above the ground; the tank being 30 feet in diameter, 38 feet in height, and is supported by concrete posts 60 feet above the ground. The tank has a capacity of 180,000 gallons or 3600 barrels. The walls of the tank are 3 inches thick at the top and 5 inches at the bottom. The posts are 16 inches square; the cost of the work is \$11,400, and amounts to only about 75 per cent of the lowest estimate on a steel tank and tower of equal dimensions. About 800 barrels of Portland Cement were used in the work.

NEW YORK AND CHICAGO

MADISON SQUARE GARDEN
DECEMBER 14-20 ~1910

COLISEUM
FEBRUARY 17-23 1911

CEMENT SHOWS

The Conventions
of the National
Association of
Cement Users
and the Associa-
tion of American
Portland Cement
Manufacturers
will be held at New
York during the
Cement Show

THE
INTERNATIONAL
MARKET PLACES
of the
CEMENT
INDUSTRY



DECORATIVE CENTERPIECE AT THE THIRD ANNUAL
CEMENT SHOW CHICAGO FEBRUARY 18-26 1910

FOR FULL INFORMATION ADDRESS THE

CEMENT PRODUCTS EXHIBITION CO. 115 ADAMS ST. CHICAGO

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue

Cable Address—"Seaferts" Chicago.

Entered at the Post Office at Chicago, as Second-class matter, July 21, 1896
under Act of March 3d, 1879.

Subscription.	\$2.00 Per Year
Foreign Subscription.	\$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON

Advertising Manager

Chicago, September 1910.

PUZZUOLANAS.

The great interest manifested by many of our readers in our editorial on the "Waterproofing Properties of Colloids" and the numerous inquiries received induce us to go into details and to describe how to proceed in making a selection between waterproofing admixtures of puzzuolana nature.

In order to most effectually fulfill the purpose of closing the pores of a mortar, a puzzuolana must be of maximum density and must contain at the same time a maximum amount of silica to be acted upon by the hydrated lime, liberated during the hardening process of the cement to which it is added. That is to say of two kinds of powdered puzzuolana of equal percentages of "soluble silica" (as that part of the total silica is termed which can be transformed into colloidal silica by hydrated lime), that is the most desirable which possesses the greatest weight per given volume, because this is the densest; it consists of the hardest minute grains, which slightly increase in volume under the action of the hydrated lime and close the pores in a very effective manner, whereas the puzzuolana of lower weight, although of the same percentage of "soluble silica", consists of minute grains which are less dense, which are loose, flaky, briefly without any body to them. These grains, which are rather voluminous from the very beginning, can not be expected, upon slight swelling under the action of hydrated lime which causes them to further increase in volume, to close the pores of the mortar as well as the dense grains of the former puzzuolana did. The first kind of puzzuolana filled the pores with dense wedges of great resistance, the second kind with loose flakes, which shrink considerably in volume at the first opportunity that presents itself, namely as soon as the mortar is allowed to dry out. Therefore, all inferior qualities of waterproofing compounds waterproof a piece of concrete only as long as it is kept in contact with water. Allow it to dry out, leave it dry for several months, and it will leak like a wooden wash tub that remained unused for several weeks.

As extreme examples of these two kinds of puzzuolana we may cite finely powdered quartz sand and dried kaolin or clay. Both are puzzuolanas under certain conditions, namely if they happen to contain a sufficient percentage of "soluble silica", which will be found to be the case only with powdered quartz sand of extraordinary fineness, for instance with certain kinds of Painter's Silica; silica, therefore, is too expensive as puzzuolana as a rule. A comparison of these two extreme cases, however, will illustrate the

meaning of maximum density of a puzzuolana. The finely powdered quartz occupies only about one-fifth the volume of the same weight of dried clay; the one represents hard minute grains and the other loose flakes.

Silica in the form of quartz sand of extreme fineness being too expensive, we have to be satisfied with the volcanic products that Nature provided by decomposing molten rock under the action of steam. These natural puzzuolanas are found at numerous places of a density only slightly inferior to quartz silica and offer the advantage of requiring only about one quarter the work of fine grinding in order to transform the rock into a suitable puzzuolana. While a high grade of natural puzzuolana ground to the fineness of commercial Portland cement can be obtained at a comparatively low cost, quartz sand, if ground to a fineness at which it would be of equal service, would have to be ground probably four times more finely at ten times the cost of the former. Quartz sand reground with Portland cement to the fineness of commercial Portland cement, a custom practiced in this country for several years, does not represent an admixture of puzzuolana, as the silica thus added to the cement was by far too coarse to act as a puzzuolana.

In a number of years, without doubt, some of the extensive puzzuolana deposits of the West will be exploited and cement users will be able to buy natural puzzuolanas in large quantities at a moderate price. To-day, unfortunately, the American market does not offer anything but high-priced products in this line. Cheaper than Painter's Silica and in most instances more effective will be found to be finely ground Pumicestone or even finely powdered glass.

In every instance, before deciding upon the application of one puzzuolana or another, the weight per volume should be determined and the percentage of "soluble silica". The latter is ascertained by boiling a sample of the puzzuolana with a 10 per cent solution of sodium carbonate for 6 hours and by subsequent filtration, precipitation, drying, washing and weighing of the silica gone into solution.

THE AMERICAN ASSOCIATION OF COMMERCE AND TRADE, BERLIN, GERMANY.

The above organization, an American Chamber of Commerce, was found seven years ago by Americans and is run by Americans on American lines for the purpose of promoting American trade with Germany and German trade with the United States. This is a thoroughly American and hustling institution, organized especially for assisting American business firms to start branches in Germany. The organization has the largest and most complete American reading-room in the empire, thirty daily American papers and 150 trade publications, all United States government reports and statistics, all the directories of the leading American and German cities, all the principal telegraph codes, all of which it places at the disposal of American business men and American travellers visiting Berlin. This Association appeals to all American business men intending to do business in Germany, whether temporary or permanent. It deserves the unqualified support of American business firms, as it can help them as no other institution or commercial agency can. Information given regarding business conditions in Germany, agents found, inquiries answered thoroughly and satisfactorily and firms actively assisted in establishing branches.

THE CALCIUM SILICATES AND CALCIUM ALUMINATES CONTAINED IN PORTLAND CEMENT.

by Dr. O. Schott.

Translated by Dr. W. Michaelis, Jr.

Although the present paper was published in 1906, that is to say prior to the time of Day & Shepherd's researches on the Lime-Silica Series, and, for this reason, does not offer anything radically new to the person familiar with the English cement literature, we believe a translation of it will be of interest to the American cement world. It differs from numerous other publications on Portland cement on account of the detailed description of the mechanical devices employed in the research work and, therefore, contains valuable hints for cement chemists engaged in similar work. The experiments carried out with the splendid equipment described by the author are quite in proportion to the laborious preparations and convince the reader of the thoroughness of the work. Some of the tests, upon which opinions differed, were repeated, not only dozens of times, but a hundred times under varying conditions.

The outcome of the work is mainly the proof of the non-existence of a tri-calcium silicate, an assumed compound, by the aid of which a number of investigators hoped to solve the constitution of Portland cement clinker, and further testimony of the fact, that the calcareous hydraulic cements do not represent well-defined compounds, but mixtures of calcium silicates and calcium aluminates with varying amounts of uncombined calcium oxide.

Of special interest are the two modifications of the di-calcium silicate, a stable form and a disintegrated modification, upon the preparation of which Dr. Schott spent considerable time; furthermore, the proof of the fact that blowing of Portland cement begins, even under the most favorable conditions, as soon as the composition $2\frac{1}{2}$ CaO to 1 SiO₂ is surpassed and that, consequently, all formulae based upon the existence of a tri-calcium silicate were misleading and have been rightly opposed by cement experts.

This publication will gain in value in the estimation of the reader, if we inform him that the researches described in it were made under the personal supervision of F. Schott, Sr., the author's father, one of the best-known cement men in Europe, and that the laboratory work was done at the famous University of Heidelberg, two facts which inspire confidence in the quality of the work.

INTRODUCTION:

The prize offered by the Prussian Minister of Public Works for the best essay on the Constitution and the Hardening Process of the Hydraulic Cements has been an inducement for many to renew the efforts made for the past fifty years in order to solve the much disputed problem of the constitution of Portland cement.

As the prize subject was so extensive that an exhaustive study of all the questions to be answered would have taken up a life-time, I confined myself to the solution of a number of points of importance and tried to explain the contradictory statements contained in the publications by the numerous investigators in this branch of science. This called for the proof of the existence or non-existence of certain calcium silicates and calcium aluminates and of their ability to harden. The possible compounds, therefore, had to be produced in a chemically pure state and had to be

examined under water. This constituted the main part of my work.

Numerous theories have been advanced in order to explain the constitution of these compounds, and yet, none of them has been able to give a satisfactory interpretation of the chemical bodies existing in Portland cement. The literature on this subject dates back to the year 1813, when Callet Descotils wrote on the constitution of hydraulic cements. He was followed by Vicat, in 1818, and later by Berthier, Rivot and Laudrin. In Germany, Fuchs was the first who wrote, in 1829, an essay on hydraulic cements. After this time, the interest taken in the solution of the problem seemed to have ceased, until in 1869 during the early period of the German cement industry Michaelis published a valuable book on "Hydraulic Mortars", which tried to explain the processes taking place during the manufacture and hardening of cements. Since then, publications dealing with hydraulic cements have become more numerous, and especially during the last 15 years much has been written on the subject. But, most essays describe products obtained under special conditions; only few authors proceeded in a systematic way and built up the various possible compounds gradually starting with the simplest. This explains the fact that only little positive knowledge has been gained, that the constitution of Portland cement has remained a mystery so far and that also the explanations given for the hardening process are based upon vague suppositions. However, two investigators of recent years, Zulkowsky and Le Chatelier, deserve the credit of having explored by synthesis the calcium silicates and calcium aluminates and of having examined their physical properties. Yet, although both started out from the same synthetical compounds, they arrived at entirely different results in their efforts to explain the complicated phenomena accompanying the manufacture and the hardening process of Portland cement. In spite of this both found ready believers.

If we consider the quantitative composition of a sound Portland cement, we find it to be composed on an average of

from 20% to 23%	of Silica
" 8% " 14%	" Alumina plus Iron Oxide
" 60% " 67%	" Calcium Oxide.

A small part of the calcium oxide may be replaced by magnesium oxide or by alkalis, and a small percentage of sulphuric acid and phosphoric acid may take the place of silica and sesqui-oxides. However, these elements occur only in amounts so small that they have to be considered as adulterations without any material influence upon the hydraulic properties of a cement. If the above mentioned limits of the main elements are surpassed, an unsound cement is obtained; within these limits, silica, alumina, iron oxide and calcium oxide suffice for the production of a well-hardening cement, a proof for the fact that magnesium oxide, alkalis and sulphuric acid do not contribute anything to the hardening and may, therefore, be omitted in the synthesis of the compounds occurring in cements. As to the relative value of alumina and iron oxide, it may be mentioned that, in 1870, my father succeeded in burning high grade cements containing no iron, but instead of the latter an equivalent amount of alumina, and also cements without alumina, in which all alumina was replaced by iron oxide. Both products showed the same properties as Portland cements with alumina and iron oxide. In modern times, Rebuffat and Newberry corroborated these statements about equality of alumina and iron oxide in cement.

The Portland cements manufactured at 90 factories in Germany from different raw materials (chalk, limestone, clay, shale) contain on an average:

Silica	22.38%
Alumina	7.83%
Iron Oxide.....	2.51%
Calcium Oxide.....	63.15%

From practical experience all manufacturers know that they have to keep their products as high in lime as possible, because the hardening properties improve with the growing percentage of lime; this, however, is true only up to a certain limit. If this lime-limit is surpassed, the opposite takes place, that is to say, the cement hardens in the beginning, but expands in time and cracks and finally loses its cohesion entirely. A surplus of one percent of calcium oxide suffices to produce this dreaded phenomenon. Practice teaches that this lime-limit is higher in the case of cements high in silica than with those high in alumina, corresponding with the higher contents of lime of the calcium silicates compared with the calcium aluminates of equimolecular proportions.

The fact that the properties of the products change entirely, as soon as the lime-limit is only slightly exceeded, seems to indicate that only a certain definite amount of calcium oxide is combined with silica and that the remainder is combined with the sesqui-oxides in some way, leaving it an open question, whether mixtures of well-defined silicates or aluminates and ferrites are formed or whether double-compounds result, or even, in addition to these, solid solutions of calcium oxide in the latter.

Even if we regard the cement clinker from a modern view point as "solid solution" or "alloy", also this interpretation necessitates certain regularities. Such solid solutions can not form in arbitrary proportions of their component parts, but are restricted to definite percentages of lime. Consequently we have to deal with compounds of limited mutual solubility of the same nature as frequently to be found in alloys of metals.

The assumption of the existence of certain regularities is sustained by the microscopic research of the cement clinker, which was first carried on by Törnebohm, in 1897, and simultaneously and independently from the latter by Le Chatelier, and which proved a valuable contribution to our knowledge of the constitution of Portland cement. Both investigators found that Portland cement clinker (the product burnt until beginning vitrification) contained two or more compounds in well-formed crystals, a statement that has been corroborated since by a number of other chemists. During the last few years, Unger succeeded even in obtaining crystals several millimeters in length, which readily lent themselves to chemical analysis and physical examination.

This seems to prove that hydraulic cements contain well-defined compounds resulting either from a mutual reaction upon one another of calcium oxide, silica and alumina at high temperatures or which, from another point of view, crystallize from a solid solution under certain conditions which have invariably to be fulfilled.

The right way to pursue, therefore, consists in producing from absolutely pure chemicals all existing calcium silicates and calcium aluminates, in studying their properties as thoroughly as possible and in drawing from the latter conclusions as to their existence in Portland cement. Thereby the main effort has to be directed towards embodying in the compounds to be produced by synthesis the highest possible percentage of calcium oxide without impairing the properties without signs of expanding or "blowing". In this direction most investigators have worked since Zulkowsky and Le Chatelier set an example in 1898.

Notwithstanding the numerous efforts made since that time, only few positive facts have become known owing to the extreme difficulties encountered in pro-

ducing really chemically pure compounds at the high temperatures required. Further unsurmountable obstacles are met with in studying the properties of the compounds, on account of their immediate decomposition by the feeblest acids and even by water. A separation of different compounds by means of these reagents is, consequently, out of the question.

Zulkowsky was the first who tried to obtain, by fusing of mixtures of their ingredients in a systematic manner, calcium silicates, calcium aluminates and calcium ferrites. He called attention to the great difficulties which he met with during the experimental part of his work. In the first place, he was unable to obtain high temperatures and, in the second place, he found that the non-existence of crucibles, capable of withstanding a heat between 1500 and 2000 centigrade and at the same time the action of silica, alumina, iron oxide and lime, made his work very difficult.

Even at the comparatively low temperature employed by Zulkowsky, the substance within the crucible was found to contain elements taken up from the walls of the crucible, thus creating compounds of a lower melting point. Also lining of the crucible with platinum did not answer the purpose, because the fused compound adhered so firmly that it could not be removed without previous destruction of the platinum crucible.

When I began my experiments, I believed to be able to get along with refractory crucibles, but, from the very beginning, made the same experience as Zulkowsky. For instance, when I intended to produce mono-calcium silicate from a mixture of calcium oxide and silica in equimolecular proportions, the mixture, which was fused over a cokefire in a quartz crucible, absorbed so much silica from the crucible wall that chemical analysis did not reveal a mono-calcium silicate, but a product of the composition $\text{CaO}, 3\text{SiO}_2$.

During a similar attempt, at which a porcelain crucible was used, the wall of the crucible was almost completely destroyed and the fusing mixture of calcium oxide and silica took up large amounts of silica and alumina, according to an analysis made of it. High-limed mixtures of calcium oxide and silica invariably have a tendency to form acidous compounds and to take up silica or alumina, whenever an opportunity presents itself.

Fusing in platinum crucibles was accompanied by success only in the case of the mono-calcium silicate and those aluminates which did not require temperatures higher than 1500 centigrade. However, the removal of the strongly adhering fused substance affected the platinum vessel to such a degree that it could not be used again. The contents could be taken out of the crucible without injury to the latter only, if the hot platinum crucible was placed directly in ice water. This sudden cooling process set up stresses in the molten mass which caused it to break up into numerous small pieces. Yet, even this method is open to criticism, as products of different physical properties result upon cooling gradually and upon sudden chilling of the fused contents of the crucible, as will be shown repeatedly in the following. Platinum vessels are out of the question, of course, if temperatures above 1700 centigrade have to be reached.

Pure di-calcium silicate and "tri-calcium silicate" sinter only at temperatures above 1700 centigrade, as I have been able to determine in opposition to the statements of other experimenters. Zulkowsky recommended for these temperatures Spaeter's magnesite crucibles. I tried five of them. They did not fuse, to be true, but resisted only one burning, as they broke into pieces upon cooling, even if cooled very carefully. A further drawback was the discoloration of the fused substance which turned brown; hence

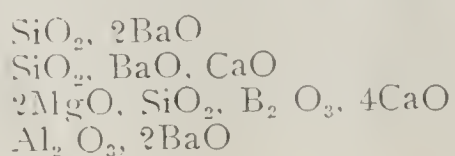
the crucible was likewise attacked by its contents and the compounds were adulterated with magnesia.

Thus, it was found impossible to obtain pure compounds in this manner. The influence of 2% or 3% of foreign substances, however, which frequently give rise to compounds with entirely different properties, I shall describe more fully later. One of the principal mistakes of most investigators has been, that they considered up to 3% of foreign elements merely as adulterations. This fact, in my opinion, explains a great number of the contradictory statements.

Zulkowsky rightly called attention to the remarkable fact, that no one has given as yet the composition of the refractory material used in the production of the calcium silicates. The reply given at that time to the effect that the question of obtaining refractory and alkali-proof vessels was not hopeless, merely served to prove how easily this difficulty is underrated. The same is true of the obtaining of high temperatures, which is not an easy matter, even if the experimenter has recourse to the electric furnace. By means of a number of contrivances, however, Zulkowsky succeeded in producing several calcium silicates, calcium aluminates and calcium ferrites.

But, in studying their properties he confined his efforts to the examination of their hydraulicity, to the time of hardening and to the heat generated upon gauging with water. Of the greatest importance he considered the determination of the water of combination after hardening for one month, as he believed to be able to draw conclusions from the combined water upon the constitution of the calcium silicates. Furthermore, he was of the opinion that comparative determinations of the water of combination of Portland cement and of calcium silicates would reveal the presence of the latter in cements. By Kanter, however, has been proven that this method can never throw light upon the subject, because the silicates of all alkaline earths contained water of crystallisation in addition to water of combination; furthermore, that all these compounds are completely decomposed by water and that both, calcium oxide and silica, go into solution. But, even if this would not be the case, Zulkowsky could not possibly arrive at accurate results, as the process of hydration was always incomplete, if directed in the way done by him. He formed small balls from the pulverized silicates and submerged them in water for a month without taking into consideration, whether or not also the inside of the cement grains were hydrated. Now, it is a well-known fact that cement, which has been kept in water for years, upon being pulverized once more, will harden again, which proves that the cores of the cement grains were not hydrated the first time. Should it be desirable to determine the water of combination in the hydrated silicates, total hydration could be brought about by agitating several times a day for about a month a small amount of the finely powdered silicate with water in a sealed flask. In this manner I conducted my experiments and determined the water of combination after three months. However, I was unable to draw definite conclusions from the figures obtained; yet, it was interesting to compare the results with those obtained by Zulkowsky.

Of the compounds which were liable to occur in Portland cement Zulkowsky produced the di-calcium silicate, the di-calcium aluminate and the di-calcium ferrite. In addition to these, he obtained a number of silicates and aluminates of other bases, as for instance:



and compared their properties with those of the corresponding calcium compounds.

The result of his work, as far as the calcium silicates and calcium aluminates were concerned, was the following:

In his opinion existed two isomorphous compounds of the di-calcium silicate; the non-active modification, the "ortho-silicate", and the active modification, the "basic meta-silicate".

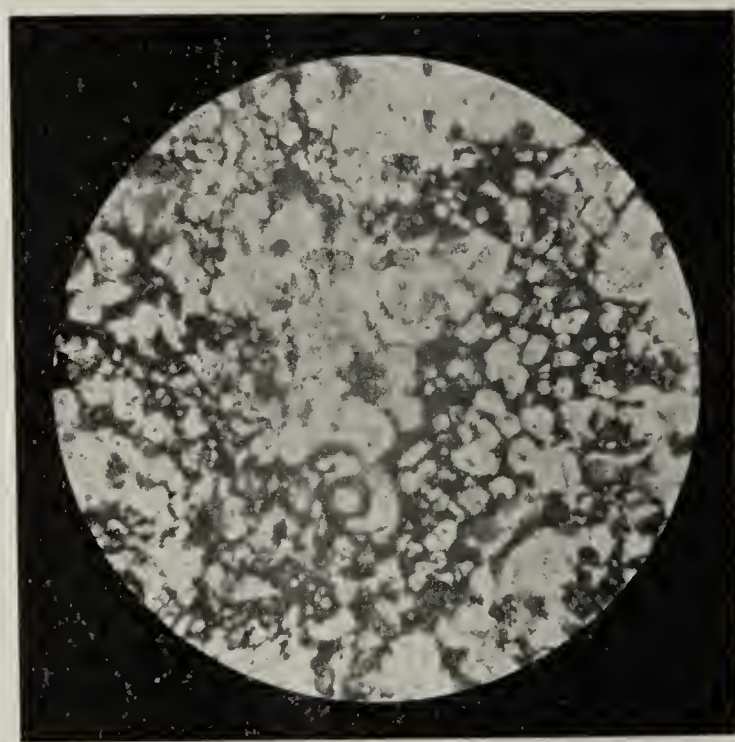
Upon fusing of the mixture of calcium oxide and silica, he believed the ortho-silicate to form at first, which at a higher temperature transforms into meta-silicate. The latter, however, is stable only at red heat and goes back into the unstable ortho-silicate upon cooling. This process causes the disintegration of the product.

This transformation did not take place, in his mind, if the red hot di-calcium silicate was cooled quickly. In this case the active meta-modification was preserved.

The meta-silicate he considered to be a strong "hydraulic", as he called substances hardening in contact with water. On the other hand, the ortho-compound, which crumbled into dust, possessed no hydraulic properties.

Zulkowsky likewise obtained the mono-calcium silicate by fusion of silica and calcium oxide and found that this compound did not combine with water; however, it swelled considerably in water.

He did not succeed in fusing a mixture answering the formula $3\text{CaO}, \text{SiO}_2$, because he was unable to pro-



No. 1. Microscopic Section of Heidelberg Portland Cement. Burnt in a Hoffman-Kiln.

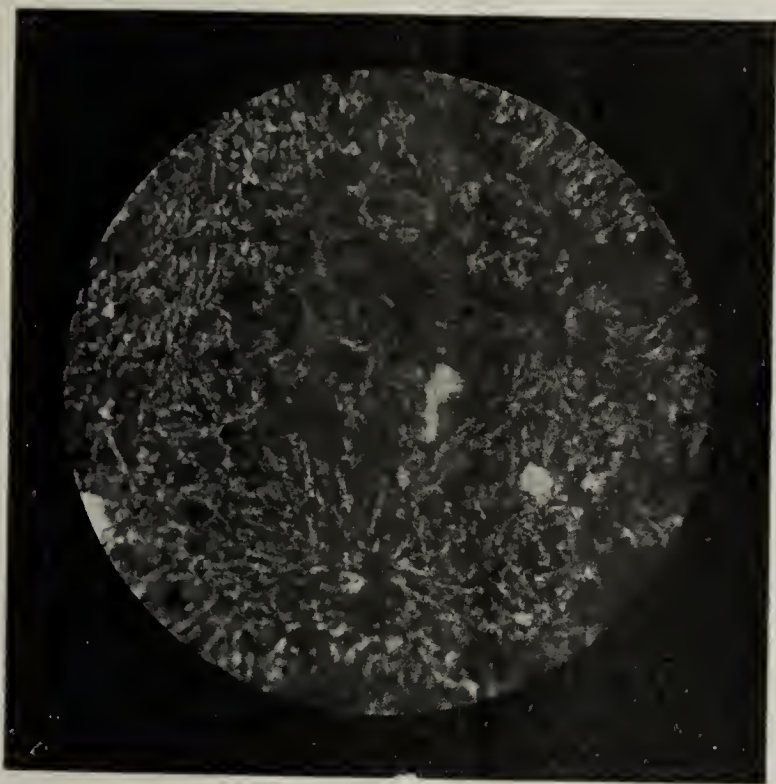
duce the temperature required for this purpose. Besides, he firmly believed the existence of a tri-calcium silicate to be out of the question, as a six-valent silica did not exist, and maintained that all chemists who claimed to have produced it, merely obtained a mixture of di-calcium silicate and calcium oxide. He called special attention to the fact that some of the believers in a "tri-calcium silicate" did not test the hydraulic properties of their products, while others obtained hardened cements from them only under certain special conditions.

Zulkowsky found it much easier to produce the mono-calcium aluminate and di-calcium aluminate, which represented two porcelain-like compounds that hardened with water within 2 or 3 minutes and were hard as rock after 3 months.

Furthermore, he produced a mono-calcium ferrite, which possessed feeble hydraulic properties.

As the summary of his work, Zulkowsky made the statement that Portland cement clinker represented a mixture of di-calcium meta-silicate, di-calcium aluminate and free lime.

In opposition hereto, Le Chatelier, who had produced by fusion, during a period of 12 years, all calcium silicates, calcium aluminates and calcium ferrites imaginable, considered a "tri-calcium silicate" to be the



No. 2. Microscopic Section of Heidelberg Portland Cement. Burnt in a Rotary Kiln.

main constituent of Portland cement. This he concluded from the following observation: In the grappiers, the sintered particles contained in hydraulic lime, which, in France, are used for the manufacture of Portland cement, he found a crystalline substance of very nearly the composition of "tri-calcium silicate", if the alumina, iron oxide and magnesia, amounting to from 4% to 6%, were overlooked.

The crystals had the following composition:

	I.	II.	III.	IV.
Silica	26.0%	26.0%	24.0%	25.6%
Calcium Oxide	66.0%	66.0%	69.0%	68.0%
Alumina	3.0%	3.5%	2.7%	3.6%
Iron Oxide	1.2%	0.8%	0.3%	0.7%
Magnesia	1.0%	1.0%	1.0%	1.3%

From these analyses he figured the average ratio of calcium oxide to silica to be 1 to 2.85 and as this came very near the composition of a tri-calcium silicate, he considered the grappiers as such. He did apparently not attach any significance to the alumina and iron oxide, but merely considered these as adulterations. In the grappiers he often noticed disintegrated crystals as crystal powder. As he observed disintegration to take place only in the case of the di-calcium silicate, he believed the powder to have this composition. The analysis of the powder, however, is missing in his reports.

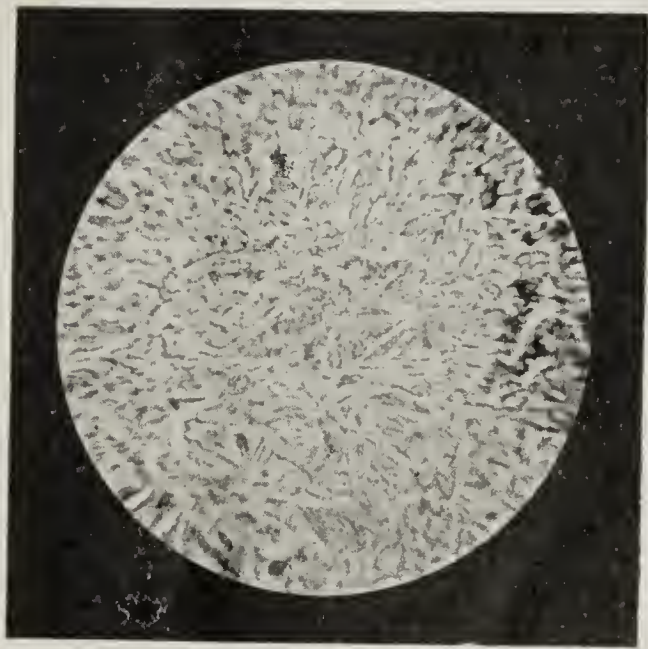
From the study of the grappiers, which yield a high grade of Portland cement, Le Chatelier concludes, that "Portland cement is an isomorphous mixture of tri-calcium silicate and di-calcium silicate, of which the former represents the active part". This assumption represents the fundamental thought of his theory.

Le Chatelier also produced by synthesis all compounds that were apt to throw light upon the constitu-

tion of Portland cement. Unfortunately, however, his otherwise detailed descriptions show an absolute lack of information with regard to the furnaces and crucibles employed by him in the manufacture of the fused compounds. Besides, analyses are missing in almost every instance, so that it is difficult to tell what percentage of adulterations his fused mixtures contained. I call attention to this, because I found out in the course of my experimental work, that it was extremely difficult to obtain silicates or aluminates which were fairly free from adulterations, that is to say, contained less than 1% of foreign substances. I had often to reject fused products which had taken up 1% or more alumina or iron oxide or carbon in some unaccountable manner.

About the mono-calcium silicate Le Chatelier made the same statements as Zulkowsky. He likewise found the di-calcium silicate not to be stable, but to crumble into dust; yet, he did not obtain a modification which hardened under water. He cited litharge, the double-sulphate of copper and potassium sulphate, as compounds which showed similar disintegration, a phenomenon which, so far as the calcium silicates were concerned, was confined, in his mind, entirely to the di-calcium silicate. A fused mixture of $1.5 \text{ CaO}, \text{SiO}_2$ broke up only into a number of large pieces. Le Chatelier did not succeed in producing a "tri-calcium silicate", because he lacked the necessary heat. However, he believed to have obtained it in a roundabout way by producing, by fusion of mono-calcium silicate and calcium chloride, a calcium chloro-silicate $\text{SiO}_2, 2\text{CaO}, \text{CaCl}_2$, which he decomposed by steam at 450 centigrade. The analysis of the purest product which he obtained in this way was unfortunately of no avail, as the silica was not determined, but merely calculated as difference. The product gauged with water and laid in boiling water, hardened well after 8 days and did not show even a trace of blowing.

Le Chatelier, furthermore, obtained aluminates and



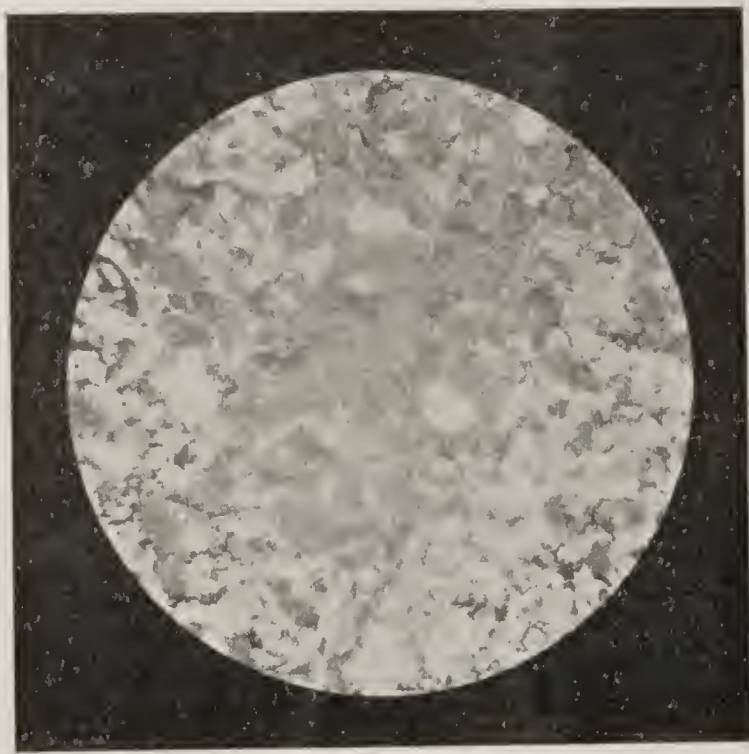
No. 3. Microscopic Section of Heidelberg Portland Cement. Fused in the Electric Furnace.

ferrites, and found that all fused products possessing less than four molecules of calcium oxide to 1 of alumina hardened well. Only beyond this ratio blowing was noticeable. His ferrites, however, were all unsound.

I purposely mentioned the result obtained by Zulkowsky and Le Chatelier somewhat in detail, because the work of all modern investigators is founded upon their theories. Another reason for so doing is my desire to compare my results with theirs.

During recent years, the work of Zulkowsky and of Le Chatelier has been supplemented

by a number of essays. Many experimenters tried to prove the existence of free lime in cement and to contribute in this manner to the final solution of the problem. To judge from the experience made along these lines, however, it seems hopeless to obtain definite results on account of the impossibility of treating cements with liquid reagents without completely decomposing all compounds present. Also gaseous reagents which I tried were equally unsuccessful. Among the few who contributed something to our knowledge on the subject



No. 4. Microscopic Section of Lauffen Portland Cement, Burnt in a Hoffman-Kiln.

were Rohland, Newberry, Oddo, Richardson and especially Unger. The results obtained by the latter, by the aid of the electric furnace, undoubtedly represent the greatest step in advance done for many years. As my work has been of a similar nature, I am compelled to outline Unger's experiments.

For laboratory experiments he employed an arc-light furnace of the Moissan type. In addition to this small furnace, he made use of a large furnace and a current of 2000 amp. at 80 volts. Instead of a crucible, he used the material itself as receptacle. However, Unger does not seem to have been sufficiently aware of the danger, to which his material was exposed, of becoming adulterated with calcium carbide by the carbon of the electrodes.

I likewise tried to obtain pure compounds in a laboratory furnace on the order of Unger's with a current of 50 amp. at 220 volt, but I did not succeed. In spite of all precautions and although I used an electromagnet which blew the particles of carbon away, I found my products invariably adulterated with from 2% to 3% of carbon, and yet the fused mass looked white. Upon submersion in water, acetylene did not always become noticeable. Afterwards I introduced the mixture to be fused above the arc-light and exposed it only to the radiating heat until vitrification or beginning fusion. This method resulted in absolutely pure compounds. But, "tri-calcium silicate" could not be obtained by this process on account of its high melting point. Unger mentioned that in his large furnace the carbon particles were carried away by the draft, but I do not believe this to be possible, because I found my mixtures always adulterated with carbon even in a large furnace heated by a current of 200 amp. at 150 volt, in spite of a powerful electro-magnet

blower. Crystals formed and broken pieces showed distinctly crystalline structure. Only a small amount of acetylene was determinable in contact with water and yet the total of calcium oxide and silica proved to be only between 95% and 96%. The percentage of calcium oxide of the fused mass was invariably lower than that of the prepared mixture. Besides, the fused calcium silicates, which had absorbed carbon, were less liable to disintegrate and in some instances did not disintegrate at all.

The absorption of carbon became especially noticeable in fusing the aluminates. These latter had so strong an affinity for carbon that the fused compounds were black and developed methane in contact with water. Various kinds of carbon electrodes gave the same results, so that I had to abandon these furnaces and to devise a different kind of electric furnace, which was no easy matter. I shall come back to this subject later in a special chapter dealing with the methods of fusion employed by me.

Unger succeeded in preparing absolutely pure calcium silicates in his furnace. His analyses gave almost exactly the percentages required by the chemical formula. The mono-calcium silicate and di-calcium silicate showed the same properties as described by Zulkowsky. The "tri-calcium silicate" obtained by him disintegrated, if it was merely vitrified, but remained stable, if it was fused completely. Gauged with water, the fused part showed blowing, while the disintegrated portion hardened well.

Unger did not produce any calcium aluminates, as he assumed these compounds not to be present in cements in an uncombined state. As the most important part of Unger's experimental work must be considered his success in producing crystals of such size, that they could be separated, analyzed and examined for their physical properties.

He furnished eight analyses of such crystals, the purest of which showed a ratio of silica to calcium



No. 5. Microscopic Section of Lauffen Portland Cement, Fused in the Electric Furnace.

oxide of 1 to 3, but contained, in addition to these elements, 8.55% alumina and 1.9% of magnesia.

Unger believed to have proven by his experiments that the main constituent of Portland cement was a double compound containing calcium oxide, alumina and silica. Whether or not this represented a well-defined compound or whether the ratio of the three

elements contained in it varied within certain limits, he did not investigate.

A number of essays on the constitution of Portland cement written by others are rather incomplete. Thus Newberry claimed to have obtained a "tri-calcium silicate" in 1898, which did not disintegrate, but hardened under water; however, even after 7 days it was still quite soft. In 1903 another publication by Newberry and Smith contained the news that they had produced a crystalline "tri-calcium silicate" which hardened; the crystal formation, however, could not be determined.

Rohland and Richardson examined Portland cement from a physico-chemical standpoint. The former succeeded in producing a non-disintegrating "tri-calcium silicate" at a temperature close to 2000 centigrade; further investigations he did not carry on. The latter considered cement as a "solid solution" of an aluminate in "tri-calcium silicate". He fused the three elements in varying proportions and drew the conclusion from his tests that cement represented a solid solution of tri-calcium aluminate in tri-calcium silicate and of di-calcium aluminate in di-calcium silicate.

Numerous publications by others reported similar results. A detailed description of all of them is unnecessary, therefore. The few examples given suffice to show the contradictory statements. Even the same author, Newberry for instance, reported five years later entirely different results. Consequently it is absolutely out of the question to draw from all these publications any definite conclusions with regard to the existence of certain compounds in Portland cement. In some points the statements coincide, but in the most essential points they differ, for instance in the decision of the question, whether or not free lime is contained in Portland cement.

Therefore, the only way for me which promised success was to produce in a systematic way all compounds that might possibly occur in cements, from the simplest to the most complicated, to study their behavior towards water and their physical properties, and then to draw conclusions based upon my own observation.

As being free of criticism, I considered in the publications of my predecessors only the determination of the grappiers by Le Chatelier and of the so-called "alite crystals" in Portland cement by Unger. These I believed to be justified in regarding as compounds, because they were crystallized.

In the foregoing I avoided intentionally to refer to the microscopical researches of Portland cement, in order not to disturb the review of the essays dealing with the chemistry of it. Since Le Chatelier, the microscope has become an important factor in determining certain compounds in cements. Le Chatelier and Toernebohm made, almost at the same time, independent from each other, microscopic investigations of sections of cement clinker and arrived at about the same results. Both observed in Portland cement four crystalline bodies and an amorphous substance which they considered as the magma from which the former crystallized. Toernebohm named them alite, belite, celite and felite. But, although they examined only a limited number of cements under the microscope, they did not always find the same "minerals". In some of the specimens one or the other was missing, and often one was predominating. Two minerals, however, were always present, namely alite and celite. According to researches made so far, alite has to be considered as the active constituent of Portland cement; it is identical with Unger's cement crystals and, in most cases, represents a compound of calcium oxide, alumina and silica.

Unger obtained by fusion in the electric furnace

cements of different microscopic structure, if he varied the percentage of calcium oxide. A Portland cement with 67 per cent of calcium oxide, which showed very high strength, contained the largest crystals. A microscopic section revealed two minerals of different colors, alite and celite. Another fused mixture resulting in a blowing Portland cement, with 70% of calcium oxide, had a crystalline structure and was lighter in color. Whether or not this latter contained only alite, was apparently not examined. However, the author mentioned that no attempts were made to produce by synthesis a fused Portland cement consisting only of silica, alumina and calcium oxide corresponding with the analysis of the alite crystals. A similar cement would have to consist entirely of alite.

Microscopic examination will undoubtedly contribute to solving the problem of the constitution. It may possibly become the sole method of determining whether or not chemical compounds have been created by fusing of the mixtures. So far, however, the microscopic examination as practiced by Toernebohm is still in its infancy, for the limited number of thin sections examined by him do not permit of a generalization of the results obtained. Unger, for instance, found alite to crystallize in the hexagonal system and often also in the form of needle-crystals. Furthermore, it has not been ascertained as yet, why one cement contains four different "minerals" and another only two.

Comparisons of microscopic sections of clinker of Portland cement of the same composition, burnt in a Hoffmann-Kiln and in a Rotary Kiln and fused in an Electric Furnace showed that the crystalline structure changed with the burning temperature independently from the percentage of lime which was the same in every instance. The section of the cement burnt in a Hoffmann-kiln resembled the clinker described by Toernebohm, while that burnt in a rotary kiln principally contained long needle-crystals; and the fused cement showed these latter exclusively as the accompanying cuts No. 1 to 5 show. It is a well-known fact that the strength of a cement increases with the burning temperature. Portland cement burnt in a rotary kiln, and even more so fused Portland cement, surpasses in strength cement burnt in a Hoffmann-kiln. Corresponding with this experience, we see, with increasing temperature, some of the crystalline bodies disappear and observe the clinker to assume a homogeneous structure in the form of needle-crystals. This suggests that, only at higher temperatures, the really active part of Portland cement obtains its full development and that, at lower temperatures, various kinds of intermediary products are formed which possess hardening properties, but not to the same degree. The section of the rotary kiln cement illustrates this perfectly. It represents an intermediary product between Hoffmann-kiln cement and fused cement and, consequently, shows little resemblance with the former and yet does not contain the needle-crystals as fully developed as the fused cement. Thus, it appears as if, at low temperatures, certain compounds are formed, namely belite, celite and felite, which, with increasing heat, unite and form double-compounds and ultimately represent a uniform crystalline mass. However, this theory would have to be confirmed by further comprehensive experiments.

The American Cement Plaster Company, Grand Rapids, Mich., is building an addition to its plant here to cost about \$50,000. New machinery will be installed. The addition will be two stories, 100x208 feet of steel and concrete.

THE EFFECT OF ALKALI WATER ON CEMENT MORTARS.

By A. J. Fisk, Jr.

The destructive effect of alkali water on concrete and cement mortars has been forcibly brought to the attention of the engineering profession on many projects throughout the West. Concrete culverts have failed and substructures have been weakened where the concrete was in contact with water or soil containing alkali. This series of tests was conducted to secure definite evidence of this destructive effect.

By numerous observations of the action of alkali water on concrete it was noted that the greatest action took place at or near the water surface. Grooves were actually eaten out of the sides of concrete culverts and parapet walls along the water line, while concrete which was constantly below water was, apparently, not damaged at all. It was, therefore, suggested that the air must be one agent in the breaking down of the concrete. With this in mind, the following theories were the basis for these tests:

That the previous mortars absorb the alkali water which, on drying out, leave the soluble salts in the concrete.

That during the drying out, the alkaline salts crystallize and expand.

That after repeated wetting and drying, the expansion due to crystallization is so great that it breaks down the minute particles of the cement.

That the greatest destructive action is mechanical.

Society for Testing Materials. No one or seven-day tests were made except in the preliminary tests of the cements.

The cement laboratory was kept within a few degrees of 70°F. during the entire period covered by the tests.

In all, 288 briquettes were tested. The tensile strength (average of four briquettes) and treatment are shown in the accompanying table.

It will be noted that for each set of tests, one-half of the briquettes were mixed with pure water and one-half with alkali water.

All briquettes were broken at the expiration of the total time indicated in the schedule. Where briquettes were cured in both pure and alkali water, they were placed in pure water first. All briquettes of the same mixture were made on the same day.

Portland Cement Briquettes.

Test No. 1 gave the tensile strength of the several mixtures when treated in the regular way, the briquettes being cured in pure water.

Test No. 2, the briquettes were cured for seven days in pure water, then placed in alkali water for 21 days. It will be noted that the breaking strengths are considerable higher than those of Test No. 1.

In Test No. 3, the briquettes were taken direct from the moist closet and submerged in alkali water for 28 days. Their average breaking strengths were somewhat higher than those of Test No. 2.

As the briquettes in Tests No. 1, 2 and 3 were treated

TESTS OF CEMENT MORTAR MIXED AND CURED WITH PURE AND ALKALI WATER.

(Tensile tests in lbs. per sq. in. Each tabulation is average of four briquettes.)

Portland cement.									Natural cement.				—Treatment—	
Mixed with pure water.					Mixed with alkali water.				Pure water.		Alkali water.		Days	Days
Test.	Neat.	1 to 1.	1 to 2.	1 to 3.	Neat.	1 to 1.	1 to 2.	1 to 3.	Neat.	1 to 2.	Neat.	1 to 2.	cured in pure water.	cured in alkali water.
1	724	621	418	261	729	600	439	248	214	168	204	181	28	0
2	838	650	454	256	842	604	463	272	228	196	222	202	7	21
3	890	653	444	238	898	648	466	270	225	206	206	194	0	28
4	752	726	474	314	691	654	486	318	257	208	252	218	56	0
5	896	746	500	363	826	722	520	347	262	202	250	214	28	28
6	310	337	292	226	276	354	317	228	154	218	150	199	28	See Note 1

Note 1.—For 28 days placed alternately in air and alkali water—2 days in air to 1 day in water.

Materials and Methods.—The cements used were a standard Portland and a standard natural, both passing the standard specifications for cement as prescribed by the American Society for Testing Materials. Standard sand was used in all mixes.

The alkali water used came from one of the small creeks tributary to Sun River, Montana. It contained 8,988 parts of dissolved solids per million—practically a 1% solution. As only five gallons of alkali water were available for these tests, not enough could be spared for a complete analysis. However, a good analysis of alkali from the same belt is given below, and it is probable the water used contained the same salts in practically the same proportion.

COMPOSITION OF ALKALI NEAR GREAT FALLS, MONTANA.

(From bulletin of Montana Agricultural College.)

.11%	Silica
4.84%	Calcium Sulphate
23.83%	Magnesium Sulphate
.54%	Potassium Sulphate
59.67%	Sodium Sulphate
7.86%	Sodium Chloride
3.13%	Sodium Carbonate

99.98% Total

All briquettes were made and tested according to the standard specifications prescribed by the American

exactly alike, with the exception of the curing, it is evident that the curing in alkali water accelerates the set, increasing the strength. The alkali water used was rich in sulphates. It is believed that the acceleration of set was due to these sulphates. To support this deduction, the following quotation is given from R. K. Mead's book entitled "Portland Cement": "With plaster paris, (Ca SO₄) H₂ O, it was found that addition up to 2% retarded set, and that above 2%, set was rapidly increased. . . . This is due to the fact that plaster paris has quick setting properties." This acceleration of set was also noted by Prof. Blazier when experimenting with sea water. D. K. Butler, in his book on "Portland Cement," quotes Prof. Blazier and says: "Briquettes placed in sea water for 28 days broke 50—60 lbs. higher than those placed under fresh water."

Tests 4 and 5 show results similar to those of Tests 1, 2 and 3.

In Test No. 6, the briquettes which had been cured in pure water for 28 days were placed alternately in air and alkali water for 28 days—two days in air to one day in water. It is thought that this treatment was similar to the physical conditions which concrete encounters in an alkali belt. The treatment may have been a little more severe than any which would occur naturally in the same length of time. Note that the

briquettes were wet nine times with alkali water and dried out afterwards. Note also that Test No. 1 shows their strength before being treated alternately with air and alkali water, and Test No. 6 shows their strength after this treatment.

The briquettes of Test No. 6 were placed under the microscope immediately after breaking. Alkali crystals were found throughout the entire section even in the neat briquettes. In fact, in the neat briquettes the crystals were more uniformly distributed throughout the cross section than in the leaner mixtures. In the lean mixtures the crystals were more in groups in the voids.

In the dense briquettes the small per cent of voids was soon filled with alkaline salts and repeated crystallization during drying out reduced the strength about 60%. In the 1:3 briquettes considerable crystallization could take place before the voids were filled. Had the 1:3 briquettes been treated for a longer time they, doubtless, would have continued to become weaker. The regular gradation in the weakening from the dense neat briquettes to the 1:3 mixture would seem to support the expansion theory.

Natural Cement Briquettes.

No acceleration of set was noted when briquettes were cured in alkali water.

It will be noted, by Tests 1 and 6, that the neat briquettes showed a weakening of about 25% while the 1:2 briquettes showed an increase in strength. The writer believes that the per cent of voids was so great in the 1:2 briquettes that they had not yet been filled with alkaline salts when the briquettes were broken. If a chemical disintegration takes place, one would expect the lean mixture to be affected first. The results from the natural cement briquettes seem to confirm the expansion theory.

Conclusions.

The use of alkali water containing 1% of soluble salts gave results almost identical with those when pure water was used.

When neat Portland cement will lose 60% of its tensile strength by being wet nine times with a 1% solution of alkali water and then allowed to dry, it is evident that the alkali hazard to concrete is a serious one. The water used was stronger than is ordinarily encountered, yet with slightly alkaline water it would merely be a matter of time until the same disastrous results would occur.

No attempt was made to find a remedy for this evil. However, it seems obvious that where water or soil containing alkali is to come in contact with concrete or cement mortar, thorough waterproofing is the only safeguard.

This set of tests is not presented as conclusive. It is believed, however, that an exhaustive study would corroborate the evidence of the disastrous physical action of alkali water on cement mortars.

THE McCASLYN CONVEYOR.

Catalogue No. 16 of the Mead, Morrison Mfg. Co. contains 150 pages of illustrations showing views of plants at which the McCaslyn Conveyor, manufactured exclusively by them, has been installed.

This conveyor is one of the best on the market for handling coal, cinders and hot cement clinker. The numerous cuts showing it in use at cement plants will convince cement manufacturers, not using this type of conveyor, that it has been of great service to

a large number of their competitors heretofore and that it saved them labor and repairs.

E. H. SARGENT'S CATALOGUE.

The new catalogue of Chemical & Bacteriological Apparatus of the well-known firm of E. H. Sargent & Co. is a great improvement over the former edition in as much as it deals with a number of subjects more thoroughly and as many new cuts have been added which will facilitate the placing of orders by chemists.

Of the greatest importance for the cement chemist are probably the following chapters: Cement Testing Apparatus, Pyrometers, Analytical Balances, Microscope, Furnaces and Distilling Apparatus, all of which contain a great deal of novel information. In addition to these, the chapters describing Electric Motors, Hot Air Engines and Autoclaves will likewise be found to be of interest to chemists who desire to equip their laboratories with modern devices.

That E. H. Sargent & Co. deal only in apparatus of the highest standard and promptly attend to all orders is well known to all parties who ever placed orders with them and hardly needs mentioning.

Every chemist of standing will do well to send for this new edition of E. H. Sargent's Catalogue and to keep it on his desk for daily reference.

MACHINERY FOR CEMENT MAKING.

Allis-Chalmers Company has just issued its bulletin No. 1444 entitled "Machinery for Cement Making." This deals particularly with Ball Mills and Tube Mills and their accessories. Numerous plates are given showing the details of the different pieces of apparatus together with installations.

In speaking of pulverizing apparatus attention is called to a very important part which the ball mill plays. In pulverizing operations for crushing dry raw material to a point where it will pass a 20 mesh sieve, nothing could be more satisfactory than the Allis-Chalmers Ball Mill. This mill has inwardly protecting shelves with spaces between them which allow the crushed material to pass through and onto the screens outside of the shelves. That material which is crushed finely enough passes through the screens while the rest drops back into the interior of the mill and is again brought in contact with the balls. One great advantage of the ball mill over other types of preliminary grinders is its compactness, no elevator, outside screens and spouts, or conveyor for returning the rejections or similar complicated machinery being required.

The Gates tube mill which is used in practically all the newer cement plants throughout the country has the advantage of being both an excellent fine grinder, reducing the crushed material so that 92% will pass a 100 mesh screen, and at the same time being one of the best mixing devices on the market.

It mixes the various ingredients of the cement so that it comes out absolutely uniform and without streaks which are so objectionable in the manufacture of cement.

Allis-Chalmers tube mill consists of a steel plate cylinder provided with driving gear. It may be lined with silex, ironite, porcelain or chilled iron. Most of the tube mill users in this country, in the cement industry, favor the silex or ironite lining. Allis-Chalmers Company manufacturers tube mills in sizes from 3½ by 14 feet to 8 by 22 feet. It also builds the necessary feeders and can supply steel balls or other crushing material.

GAS PRODUCERS AND ROTARY KILNS.

By Nisbet Latta.

Upon a review of the "Notes" which appeared in the November issue of "Industrial Progress", it will be seen that an attempt was made to point out the extreme and needless waste which results from common methods of handling fuel. It was further shown that to continue the present course would soon lead to greatly increased cost of power generation. A comparison was made between the generation of power by steam and the using of coal in a producer gas plant and the saving which might be accomplished by proper methods was clearly brought out.

The present article deals with further considerations concerning the best and most economical methods of handling fuel and a study of some of the cases in which gaseous firing brings better results than direct firing.

It is shown that with some of the poorer grades of coal such as the Texas lignites, the physical action of the coal tends to prevent its successful handling by direct firing. At the same time this fuel's chemical composition is particularly suited to the requirements of manipulation in gas producers and gas firing.

Considerable attention is also paid to the application of gas in the manufacture of Portland cement and lime. The various methods of cement manufacture are considered and a very careful analysis of the heat requirements, of one method, are worked out. This shows a very great increase in efficiency with the use of gaseous firing over the ordinary method now practiced of burning the coal directly. In fact it is easily possible, with careful designing, to increase the heat efficiency 100%.

In the manufacture of lime, by using the rotary furnace and gas firing, it is possible to not only greatly decrease the cost but to also materially improve the quality of the product, giving it more uniform characteristics and preventing its discoloration.

All citizens are interested in conserving the natural resources of the country but few realize that this can be done without increased cost in some way. It is the object of these notes to point out to the manufacturer how he can do his share in the conservation scheme and at the same time reap larger rewards from his business.

Up to the present time the most economical form of utilizing heat is found in the gas producer, better termed perhaps, two stage combustion. This operation has become too widely known to create a necessity for its description. The reason for its efficiency, however, is perhaps less clear in the public mind.

Comparison of Direct and Gaseous Firing

The efficiency of two stage combustion depends principally upon three functions: the ability to recuperate waste heat; the ability to deliver the heat at the most effective point of application or to distribute it with uniformity and without localization over any reasonable given area; to perform combustion without an excess of air, thereby preventing the loss of the sensible heat of the effluent gases and air excess.

There is also another reason which, although hardly an exclusive function of two stage combustion, is rarely found in the working of the direct fired furnace, namely, complete combustion of the fuel. The circulation of the gases in a direct fired furnace is usually so rapid as to carry the volatile element of the fuel or product of distillation beyond the ignition zone before ignition takes place. Passing beyond this heat area or zone at a rate greater than that of its flame propagation, these gases reach a lower temperature area and, failing to ignite, escape unconsumed, creating a considerable loss.

In furnace work, or in commercial heating operations, other than power, there may be said to be two classes

of heat application. In the first class may be placed boiler firing, forging and tempering of metals. In the second class may be placed practically every other class of industrial heat application.

In boiler practice gaseous firing is relatively less efficient than the direct application of heat because of the fact that intense localization of heat is an advantage. Water is a much better conductor and transferring medium of heat than air or gases, and when it is heated locally a circulation is started which tends to distribute the heat throughout the whole boiler in an extremely efficient manner.

As a matter of fact experiment has shown that high localization of furnace temperature is a material advantage under conditions of modern boiler design.

The gaseous firing of a boiler possesses the disadvantage of bringing the gas during combustion, in contact with a relatively cool surface, producing "shock," the effect of which is dual. First the reduction of temperature serves, as before described, to permit a certain portion of the gases to pass beyond the ignition area at a rate faster than their flame propagation, and consequently escape unconsumed. Second, the sudden change in temperature tends to precipitate certain of the carbon and hydro-carbon compounds with a resultant formation of soot and lampblack, which is seldom completely consumed, and which is most objectionable, due to its insulating character. The ideal design for the gaseous firing of the steam boiler would be an arrangement based upon the "reverse current" principle, which is found most satisfactory in gas engineering for all forms of heat transference work. In other words the hottest gases would under this arrangement serve to super-heat the steam, while the effluent gas and products of combustion would pre-heat the water and bring it up to ebullition.

This arrangement has been very successfully carried on in laboratory experiments, but the physical construction of the modern boiler will not permit, in practice, such an arrangement. The tube sheets, tubes, etc., are unable to withstand high temperatures where not protected by a water content or cooling action, this being the reason of course that the water leg of the boiler is usually brought in close contact with the point of highest temperature within the furnace.

Although for the several reasons named, and others, two stage combustion is less effective in the production of steam, (relatively speaking) than that of any other heat productive operation, there are instances where its use is fairly satisfactory, and even in cases essential to commercial service.

These cases are more particularly in the use of low grade bituminous fuels in which may be classed lignites and peat, different varieties of culm, and in fact nearly all of those fuels whose thermal value is less than 10,000 B. T. U. per pound.

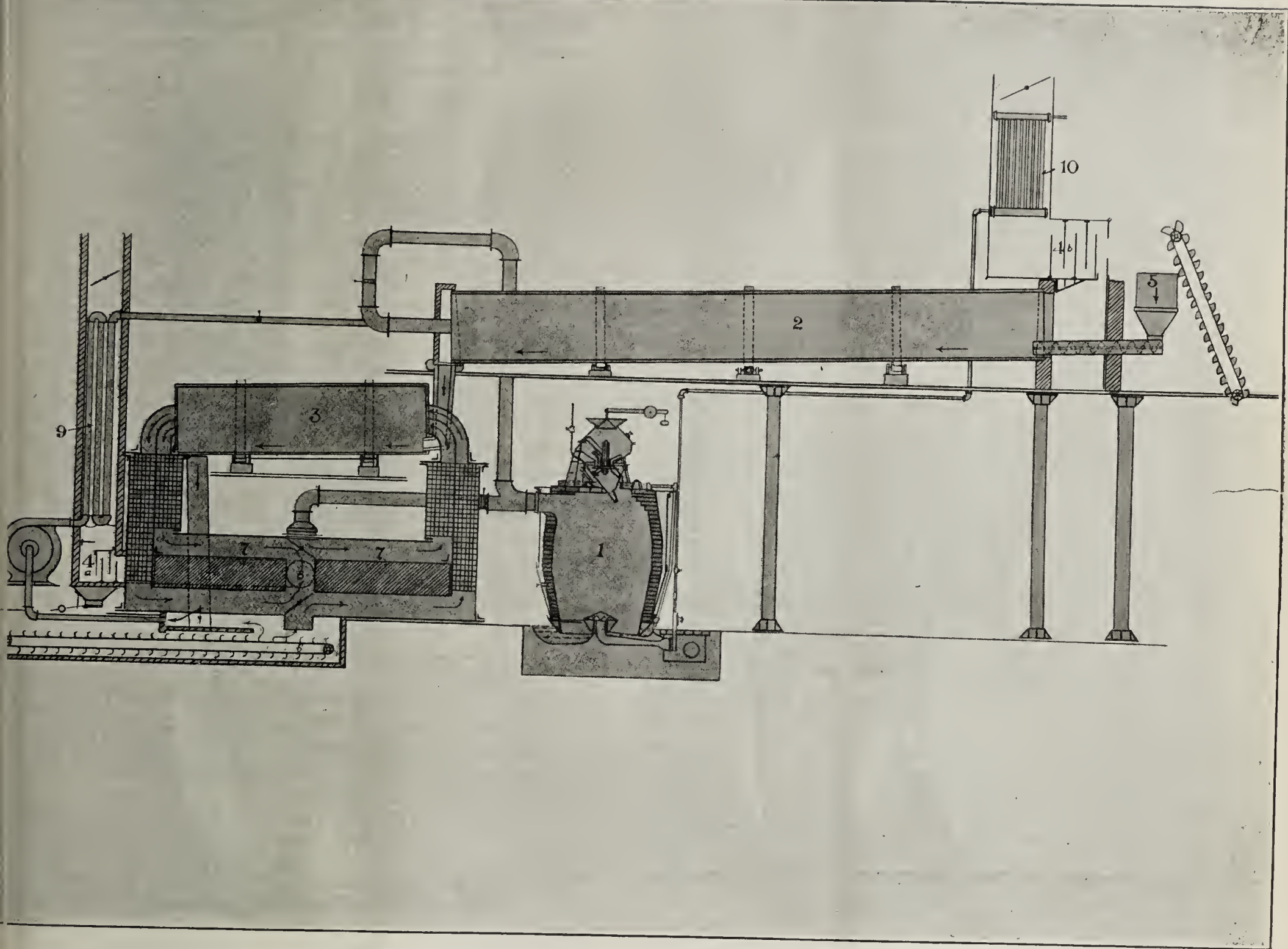
There are several reasons for this condition of affairs, among which, first and foremost is their large volatile content, in proportion to the fixed carbon. In combination with this, their flame and heat propagation is exceedingly fast. The result of this combination is that the volatile matter, constituting the binder or "sizing" of the coal, rapidly distills out at an early stage of the combustion, the gases moving with extreme rapidity, faster in fact than their flame propagation, a large percentage escape unburned and the residual carbon and ash being left without a binder tend to "Fine," clogging up with their finely powdered mass, all source of draft. Their density being nearly impenetrable, a condition of mass action occurs, whereby the residual carbon is "packed" insulating its particles from the incoming air, and so remains partially, at least, uncon-

bined or unburned, resulting in a large fuel waste due to carbon thus unconsumed. It also tends to choking of the grates, creating an undistributed draft, and a general irregularity of combustion.

Again the large ash content of these low grade fuels tends to stop, either completely or partially, the grate voids, where such are small. In the former case combustion is stopped and in the latter case clinker is created due to a concentration of draft, and the subtended combustion in "spots", causing a blanketing effect and a baffling or diverting of the draft into channels. To ob-

decompose coal at a temperature below the fluxing point of fusible ash hence preventing clinker, a condition impossible of attainment in direct firing.

The other items in the first class, namely forging and the tempering of metals, have been mentioned in as much as they depend entirely upon a localized heat, but even so it is questionable whether or not some chemical or metallurgical advantages are not to be had from the use of gaseous fuel. Principally because the heat obtained is more uniform in its nature and the chemical elements of combustion are more nearly regulated, also



CEMENT KILN LAYOUT FOR MAXIMUM THERMAL EFFICIENCY

1, Producer; 2, Calcining Kiln; 3, Clinkering Kiln; 4, Dust Separators; 5, Feed Hopper; 6, Receiving Vault; 7, Regenerators; 8, Reversing Valve; 9, Recuperator; 10, Economizer.

viate this, either grates with large voids must be used or the natural angle of repose of the fuel utilized. Were this done in direct firing, the result would likely be combustion with an excess of draft highly uneconomical, or, should the draft be restricted or throttled by dampers to a sufficient extent to compensate, there would be a lack of circulation, retarding combustion. Hence it will be seen, that for the utilization of low grade fuels, it is essential to arrange some method of combustion, which will not only recover the volatile matter liberated so rapidly, but it is also necessary to control the draft in such a manner that the fuel may be decomposed without an air excess. It is also possible to a great extent, especially where gas is to be consumed in furnaces, to

(under satisfactory conditions), there is a greater freedom from, or less danger of, impurities in metallurgical combination.

Under the second class we find practically all of those industries where it is necessary to apply heat to certain material, vessels or containers, instead of bringing said material or containers to the heat, as is the case to some extent in boiler circulation.

Gas Firing in Cement Manufacture.

As an example of the second class, perhaps no better illustration can be cited than the manufacture of cement and lime, and an outline of the possibilities of complete

regeneration or heat recuperation in the calcining of the former is herewith given.

In the modern practice of producing Portland cement in the U. S. it is practically all burned in a rotary kiln fired usually by the burning of a flame plume of pulverized coal axially within the kiln, though oil and natural gas are sometimes used. The raw materials used in the manufacture may be divided into three groups as follows:—

First Group:—This consists of what are called cement rocks from their having been formerly used in the manufacture of natural cement. These consist of rocks having nearly the composition of Portland cement and with the lime, alumina and silica already in combination to some extent. To these rocks is usually added enough limestone to produce cement of the proper analysis and this mixture is dried, ground and fed into the rotary kiln.

In the second group may be placed a mixture of limestone and silicious clay, dried and ground and fed into the rotary kiln. In burning this mixture, the water of hydration must be dissociated from the clay, the mixture must be raised to the dissociation temperature of limestone, from 900 to 1000 degrees C, and the carbonic acid must be driven off and the resulting lime and baked clay, brought to the temperature at which sintering takes place, about 1300 degrees C. At this temperature a combination of the lime with the silica takes place, forming among other compounds dicalcium silicate and dicalcium aluminate, which are considered as the active substances of cement.

The third group consists of marl, which is finely divided calcium carbonate, which has originated from sea or fresh water shells, with which is mixed enough clay and sand to give the proper proportions of lime, alumina and silica. This mixture is ground wet into a slurry, and fed into the rotary kiln in a semi liquid form, and is there dried and burned.

In the mixtures of the first group the amounts of lime combined with the silica and alumina and the amount combined with the carbonic acid to form limestone are quite variable, so that the amount of heat necessary to produce cement from this mixture would differ in each case and cannot be accurately determined until all the elements of the mixture are analyzed.

In the third group the amount of water is so much and so variable that the fuel requirements cannot be determined until the amount of water present is known.

In the second group however the constituents are assumed to be pure and these will be selected as the mixture on which the heat determination may be calculated. It will be assumed that the theoretical cement produced is to have the following composition:—

Lime (CaO).....	68.25%
Silica	19.72
Alumina	11.93

All the other constituents found in commercial cement are accidental impurities, and it is well settled that they do not improve the cement, and most of them should be guarded against, lest any excess impair the quality of the product.

To produce a cement of this quality, requires that the following ingredients be used in the proportions named.

Limestone	121.20 Kgs.
Clay	32. "
Sand	4.8 "

Total weight of mix 158 Kgs.

Therefore 158 Kgs., of raw mixture will make 100 Kgs. of cement.

The operation may be divided into two stages, and the heat requirements will be here calculated for two operations viz. of calcining and clinkering, the first of these consisting of heating the mixture to 900 degrees "C" thus dehydrating the clay and decomposing the limestone.

The heat requirements for producing calcines are as follows:—

For dehydrating the clay there will be required 1218 Cal. per gram of water dissociated from the clay $H_2O = 4.5$ Kg.

For dissociating CO_2 from limestone requires 1026 calories per Kg. of CO_2 . For heating the charge it will be assumed that the specific heat of the mix is, at lower temperatures about .25:—

$$158 \times 4.5 = 153.5 \text{ Kg.} \times .25 \times 900 = 34,537 \text{ Calories for heating.}$$

$$4.5 \times 1218 = 5,480 \text{ Calories for dehydrating clay.}$$

$$121 \text{ Kgs. Ca } CO_2 = 53.2 \text{ Kgs. } CO_2 \times 1026 = 54,600 \text{ Calories for dissociating limestone, giving a total of } 94,617 \text{ Calories for producing calcines.}$$

For sintering the heat requirements are very much less; in fact the exothermic reactions produce one third as much heat as is absorbed in heating the calcines to the sintering temperature, hence the advantage in dividing the process into two stages. The heat of combination of lime with silica and alumina in cement does not seem to have been accurately determined by Le Chatelier, who determined that in the combination of 3 CaO. Al_2O_3 $2SiO_2$ that there were 150 Cal. developed per unit of Al_2O_3 . $2SiO_2$ and as the silica and alumina exist in about that ratio in the cement their sum multiplied by 150 Cal. will give the heat produced.

In heating the calcines from 900 to 1300C. their specific heat is assumed to be .30, therefore:—

$$100 \times .3 \times 400 (1300-900) = 12,000 \text{ Calories absorbed by clinker.}$$

$$31.65 (SiO_2 \text{ and } Al_2O_3) \times 150 = 4,747 \text{ Calories produced.}$$

The total heat units in the clinker as discharged would be as follows:—

$$100 \text{ Kgs.} \times 3 \times 1300 = 39000 \text{ Cals.}$$

The above represents the heat requirements, provided that the combustion gases left the kilns cold and the carbonic acid gas from the limestone left the kiln at the temperature of dissociation.

Practical working tests with a gas fired rotary kiln 100 feet by 6 feet in diameter, burning limestone crushed to 2-inch size, such limestone containing 98% $CaCO_3$, have shown that it is safe to assume an output of six parts of lime to one part of good gas coal; therefore 66 Kgs. of lime would require 11 Kgs. of fuel, and as there are 66 Kgs. of lime in 100 Kgs. of cement, 11 Kgs. of coal would calcine all of the lime to produce 100 Kgs. of cement. There remains only the heat requirement for bringing 33 Kgs. of SiO_2 plus Al_2O_3 to the required temperature at which the lime is formed.

SiO_2 plus $Al_2O_3 = 33 \text{ Kgs.} \times .25 \times 900 \text{ Deg. C} = 7425 \text{ Cals.}$ which would be equivalent to not more than 1 Kg. of coal per 100 Kgs. of calcines, therefore,

Estimate of Coal Consumption, Calcining Kiln.

11 Kgs. of coal for heat to produce 66 Kgs. of lime.
1 Kgs. of coal for heat to raise temperature of clay.
 $\frac{1}{2}$ Kgs. of coal allowance for heat losses in heating up clay.

Total:—

$12\frac{1}{2}$ Kgs. coal per 100 Kgs., calcines or one coal to eight calcines.

Clinkering Kiln.

For clinkering, estimating that the calcines are discharged directly from the primary kiln in to the clinker kiln at 900 Deg. C and are therein heated to 1300 Deg. C a range of 400 Deg. rise in temperature.

$$100 \times 3 \times 400 = 12,000 \text{ Calories absorbed.}$$

The clinkering operation is exothermic and as Le Chatelier has determined that 150 calories are evolved per unit of combined $\text{SiO}_2\text{Al}_2\text{O}_3$ therefore 31.65 Kgs., (Combined silica and alumina) $\times 150 = 4747$ Calories.

Subtracting this from the 12,000 calories absorbed by the calcines in the clinkering kiln there remains 7253 Cals. per 100 Kgs. to be furnished by the fuel. This represents slightly less than 1% fuel for clinkering.

Assuming 180 tons to be clinkered per day in one clinkering kiln, 180 tons = 18,000 Kgs., divided by 100 = 1800 Kgs. of coal or 1%. There remain 39,000 Cals. in the discharged clinker, and assuming that $33\frac{1}{3}\%$ of this heat can be taken up by cooling with air and supplied to the primary or calcining kiln, 13,000 Cals. would be afforded per 100 Kgs. cement = $1\frac{1}{2}$ Kgs. coal, or $1\frac{1}{2}$ Kgs. of coal per 100 Kgs. of Cement which subtracted from $12\frac{1}{2}$ Kgs. of coal used in calcining gives 11 Kgs., or 11% fuel, or one of coal to nine of Calcines.

Assuming an efficiency in the clinkering kiln requiring 4 Kgs. of coal per Kg. of cement. $1800 \text{ Kgs.} \times 4 = 7200 \text{ Kgs. coal.}$ This would be 4 Kgs. per 100 to be added to the 11 required for calcining or a total of 15 Kgs. per 100 Kg. cement or 15% one of coal to 6.6 of cement.

A regenerative system such as is shown in the illustration is capable of utilizing 84.2% of the total heat of the gas, and the producer should have an efficiency of 80% thus giving a combined efficiency of 67% for the producer and kiln, not allowing for radiation loss. It would be safe to assume 50% efficiency for the clinkering kiln outfit, allowing 17% for loss by radiation. If this result is realized the process would yield 7.69 Kgs. of cement for each Kg. of coal consumed.

This, as will be seen, effects a saving of more than one half of the present fuel consumed under average direct firing practice or an increased efficiency of over 100%.

The Rotary Kiln and Gas Firing in the Production of Lime.

The second example, that of lime, is particularly interesting. It is a paradoxical fact in the calcining of limestone that the softer the stone the more difficult it is to burn, and the greater the amount of fuel required for its complete calcination. This is again due to certain conditions of mass action. At a stage quite early in the process, and before all of the carbon dioxide is driven off by the action of the heat, the stone "fines" form a dense granular mass so compact as to largely exclude the passage of draft and escaping gases, and to some extent insulate large portions of the charge from the action of heat.

It is obvious that where calcining is performed by direct firing with high localized temperatures it necessarily follows that those portions of the charge immediately adjacent to the furnace may be considerably overburned. This condition is materially reduced where the combustion is gaseous, by reason of the voluminous flame and the permeating powers of the air-gas mixture, combustion taking place within the limestone charge itself instead of the furnace. In the latter case the charge would only be reached by radiant heat, and an inconsequent amount of conducted heat from the sensible heat of the effluent products of combustion.

Practically all of these objections are met by the use of the rotary kiln in lime manufacture, which offers a very perfect calcination due to the exposure of each integral part of the limestone to the action of the heat, and by its rotary motion permitting each side of the limestone fragment to become exposed in turn. It also permits the utilization of spawls, and calcines with equal efficiency practically every form of lime carbonate.

To utilize the rotary kiln, it is of course necessary to crush the limestone, and to this there seems to be some trade prejudice, the product of years gone by, so remote as to have lost any definite reason for existence, save a general idea that the pulverized limestone has an additional tendency to air slack. Opposed however to this, is the fact that lime in lump is apt to be over burned at the surface while not completely calcined or de-carboxized at its center, hence making the lime dark in color, slow to slack and weaker in strength.

Certain it is from a commercial standpoint, (which after all reflects the true worth of the matter), that the rotary kiln yields some six pounds of lime per pound of coal fuel used, and even the old fashioned shaft kiln yields on the average five pounds of lime per pound of coal fired, a result double in efficiency that obtained under conditions of ordinary direct fired shaft kiln practice using forced draft or aspirating with steam.

Of course any efficiency reflected in the foregoing examples is undoubtedly due in the main part:— first, to the ability to attain complete combustion with the theoretical complement of air, (in practice with gaseous firing, the excess need not exceed 10% while in direct firing the air excess may run from 300 to 700%), and to the ability to recuperate waste heat and return it in suitable condition to useful work.

Again, as cited, the ability to distribute the heat most effectively as opposed to localization, is most important. Butterfield notes; "a discrepancy of temperature within the field of a furnace heated by direct firing showed an extreme difference of 400 degrees". This difference under conditions of good design with gas firing, will not exceed 200 degrees C.

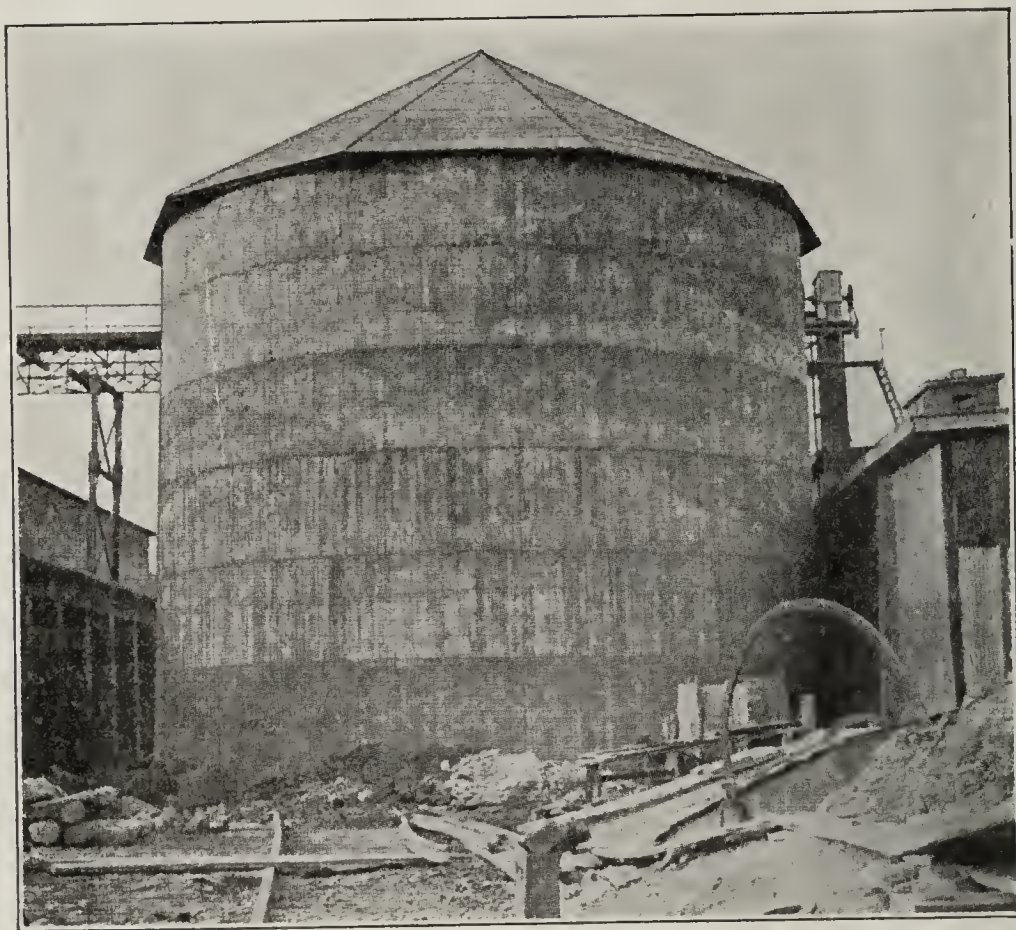
Euchene found the maximum temperature of a direct fired furnace to be 1375 degrees C. the products of combustion leaving the furnace at 975 degrees C., the heat duty reflected by this differential of temperature or "drop" being approximately 29%. In a regenerative setting the maximum temperature was 1250 degrees C. the products of combustion escaping the recuperator at 1050 degrees C at the outlet of the furnace to 600 degrees

This would apparently show a thermal advantage upon the part of the direct fired furnace, the total heat abstraction being greater upon its part. It however only indicates a concentration of heat abstraction, such abstraction being unequal and localized, for Euchene further notes, upon a Siemens alternating recuperative set, that in traversing the recuperator the temperature fell from 1050 degrees C at the outlet of the furnace to 600 degrees at the outlet of the recuperator. Hence the total drop in the temperature in the furnace, plus the recuperator combined, (and which from an economic standpoint must be taken as a whole), was from 1250 degrees C to 600 degrees C, a total abstraction of 650 degrees, showing a heat duty or thermal efficiency of 52% or a gain in absolute working economy of 325% (approximately). Even this thermal temperature is excessive and could be materially reduced by additional heat absorbing and regenerative surface with commensurate economy. Taking these figures however, not only does this comparison show an efficiency more than triple that of the direct fired furnace, but the abstraction of the heat is more gradual and uniform, and the cycle possesses less irregularities or severe variations.

TANK OF REINFORCED CONCRETE FOR STORING PORTLAND CEMENT AT THE PLANT.

One of the primary features in connection with a Portland cement mill is that the plant be so arranged and conducted that there will be as little labor as possible with the best results obtainable. Every convenience should be studied, and the plant so equipped that there will be nothing to mar the possibility of not only the best product, but also the most approved methods of manufacturing and handling of cement.

A reinforced concrete tank for storing cement was recently constructed at the mill of the Louisville Cement Co., Speeds, Ind. The height of the tank is 45 feet, and the circumference is the same. It is located between the finishing mill and the shipping department, and has a capacity of 18,000 barrels of cement. The bottom is built hopper shape, and it has seven outlets, with three tunnels erected beneath for removing the cement by vertical conveyor to the shipping department.



The tank shown in this figure is one of large diameter, considering its height, and is for the storage of water. It is 45 feet in diameter and 45 feet high.

The time required for the construction of this tank was two months, and it cost \$8,500. Speeds Portland cement was used in the work, and a mixture of 1:2:4 was used. River sand and crushed stone were the aggregates. The tank is reinforced with the bars of the Expanded Metal and Corrugated Bar Co., ranging from 1 in. to $\frac{1}{2}$ in. The bottom is reinforced with bars 6 in. on centers, and has a most compact system, making the strength very great. The walls are 9 in. thick. All the work was done by the Holmboe Co., of Louisville, Ky., concrete engineers.

This storage tank will greatly facilitate the handling of the cement, and as the work is done by conveyor there will be nothing to interfere with its operating. The company is highly pleased with the tank, and anticipates great results from its use. It is an innovation among Portland cement plants, and is one that will no doubt prove most helpful.

CONSTRUCTING HOUSES IN THE TROPICS.

The first thing to consider in erecting a bungalow or house in the tropics, says a writer in the "Colonial Office Journal," is coolness, and this turns largely on the climatic conditions. If the nights are cool, the building should be so designed that the occupants can live in a natural breeze, and materials such as wood for walls and shingles for roofs, which rapidly cool down after sunset, are more suitable than masonry, which absorbs heat in the day and gives it out all night. If, on the other hand, the nights are hot, the object should be to cool the hot air and use punkahs to make a breeze. But white ants, wherever they exist, attack wood, and innumerable insects find homes in the joists. Bricks are durable and clean, and though they cost usually about 10 per cent. more than steel framing and timber, the upkeep is less and the life longer. In such countries as West Africa masonry walls are clearly the best. But frequently the question is not what is the best material, but what is available locally, and the prevalence of wood and iron houses is due to the fact that they can be put up quickly and cheaply. As reinforced concrete can be

made in strong but thin and light slabs, it will probably be largely employed in future. But thick masonry walls keep out the heat well, and cannot be surpassed in localities where the materials are available. Where there are white ants, masonry in lime or cement mortars should be used.

Corrugated steel (formerly corrugated iron) is the most usual material for roofing, and whenever so used there should be a good air space between the roof and the ceiling. Ventilators should not be placed in the ceiling, but in the upper part of the walls; they should also be provided in the steel roof to let out the hot air which accumulates above the ceiling. In Australia, double corrugated steel with an air space between is used with satisfactory results. Slates and tiles keep out the heat better than iron, but are breakable and expensive to transport. Eternit slates and uralite have been put on the market as a substitute, and appear to

contain a large amount of asbestos; they are in use in Lagos. There is refrigerating composition that can be used in metal or tile roofs, and in a recent trial by a colonial government it was found that during the full heat of the sun the temperature of roofs so treated did not rise above blood heat, and were always cool to the touch when other roofs were too hot to touch. Where there are no white ants, matting over the ceiling, with a mud plaster over it, makes a cool roof. In India some experiments have been made of reinforced concrete roofs. At Cawnpore a reinforced roof 6 in. thick was placed over a 5-in. jack arch roof, with an air space between; on May 1 the temperature in this room was found to be 90°, as compared with 105° in a building with only a single jack arch roof.

There is a good deal of difference of opinion as to whether the bungalow should be well raised above the ground or not. But in cases where it is necessary to keep it open so as to cool it by the breeze, and the soil is dry and dusty, the floor must be raised well above the ground, say some 8 feet, so that a man can get in to keep the space clean; otherwise the space must be enclosed as there is a temptation to use it as a store-room, when it is likely to become a nuisance. There is strong evidence in favor of making houses mosquito proof by using gauze, but in a hot and damp climate there is a great temptation sometimes to let the breeze in. The best way of using gauze netting is to put it round the veranda and to make porches where entrances are required. The "Panama Canal Record" says that "the wire netting should be No. 18 mesh of bronze or brass. The presence of 1 per cent. of iron in the brass alloy will often cause corrosion."

In the West Indies verandas are generally not used on account of the hurricanes, but in West Africa verandas are necessary and become part of the house, the extent depending on the climate. If one veranda only is required for sheltering the walls a narrow one suffices, but if it can be used to sit or sleep on for a great part of the year it should be 10 ft. wide or more. The sleeping-room should, for the sake of airiness, contain as little furniture as possible; a dressing-room and a store-room should be provided. Rooms in which punkahs are to be hung should not be less than 11 ft. high. Where a cooling breeze blows regularly the building should be placed so that the wind may blow through it; otherwise the best plan is to make the length of the house run east and west, and the front and back north and south, so that when the sun is low it may strike as little of the house as possible. The direct sunlight is too powerful for comfort, therefore the lighting should be independent of the openings into the veranda. Light can be admitted through clerestory windows below the veranda roof, or if above, screened from the sun. The ceiling and upper parts of the walls should be whitewashed so as to increase the light, and this can be done without detriment to the appearance if the whitewashed surface is treated as a deep frieze.

THE NEW SILICA BRICK AND STONE FACTORY AT ALBANY, GA. BEING OPERATED VERY SUCCESSFULLY.

The International Sand, Lime, Brick and Machinery Company, 90 West Street, New York has recently erected a Single Unit factory at Albany, Ga., for the manufacture of Silica Brick and Stone under the patented "Division-Method." The factory is now in operation and producing the highest grade Silica Brick and Stone which has ever been produced and the product has found a ready market from the very start.

It has a capacity of 40,000 brick and 200 cubic feet of stone per day of 24 hours.

A MODERN STONE CRUSHING PLANT OF 600 CUBIC YARDS CAPACITY PER HOUR.

With the ever increasing demand for crushed stone for various concrete constructions and for industrial uses, the production of this material has increased, in the last few years, to enormous proportions.

The increase in the demand in Chicago and vicinity in particular, is due to the great activity in all kinds of building and other construction, and also partly to the development of iron and steel manufacture in the Calumet region, where a large quantity of limestone is required for use as a flux in the blast furnaces.

Southwest of Chicago, along the line of the Chicago Main Drainage Channel are large deposits of limestone, which outcrop on the surface. Many crushing plants, large and small, are in operation in this district. Among these plants is the new plant of the Dolese & Shepard Co., of Chicago. This plant was built in a period of ten months, after the burning of a former plant on the site, and has now been in operation eight months. This plant is interesting as a whole, because of its capacity and its output, and is interesting in detail because of many features which are departures from standard methods and which in many details are of original design. Many of these features are due in a considerable degree to Mr. Geo W. Pantnoe, Master Mechanic and General Superintendent for the company, who has been in direct supervision of the design and construction of the plant. The whole plant is the outcome of 30 years of experience in the business of quarrying and crushing stone for the Chicago market.

Quarry.—The company owns about 300 acres of land of which 130 acres are available for quarrying purposes to a depth of 150 ft. as tested by core drills. It is estimated that it would take about 75 years to exhaust the rock within the limits examined. The quarry was opened a few years ago and, up to the time of the destruction of the plant by fire in the early part of 1908, was operated according to standard quarry methods. The quarry as now opened has an area of about 21 acres and a depth of 40 ft.

The new system of quarrying and handling the rock consists of drilling with well drilling machines and loading the rock with steam shovels into electrically operated dump cars. The well drilling machines have proven a decided economy over the small tripod drills. Records have been kept which show each day's work with length of time worked, depth of holes drilled, time not drilling and for what reason, quantity of repairs, name of drills and date.

When the new plant was started it was intended to use electrical equipment throughout, and a trial was made with an electric shovel. This, however, proved too slow for the work. The company furnishing the shovel put it out as an experiment and will replace it with a steam shovel. The swinging motion worked very satisfactorily, but the 200-h. p. motor could not accelerate fast enough for handling the dipper at the required speed. The capacity of the shovel did not exceed 1,200 cu. yds. in 10 hours. The steam shovels are expected to handle 1,800 to 2,000 cu. yds. in that time.

Another of the departures from the ordinary was the adoption of an electric haulage system. This system uses a third rail placed in the center of the track and the cars are controlled by one man who is located in a tower which commands a view of the greater part of the track system. The system is the invention of F. E. Woodford, President of the Woodford Engineering Co., Chicago, and was installed under his direction.

Much discussion was caused in engineering circles when this system was installed for stone quarry use, and many predictions of its failure were made. It is

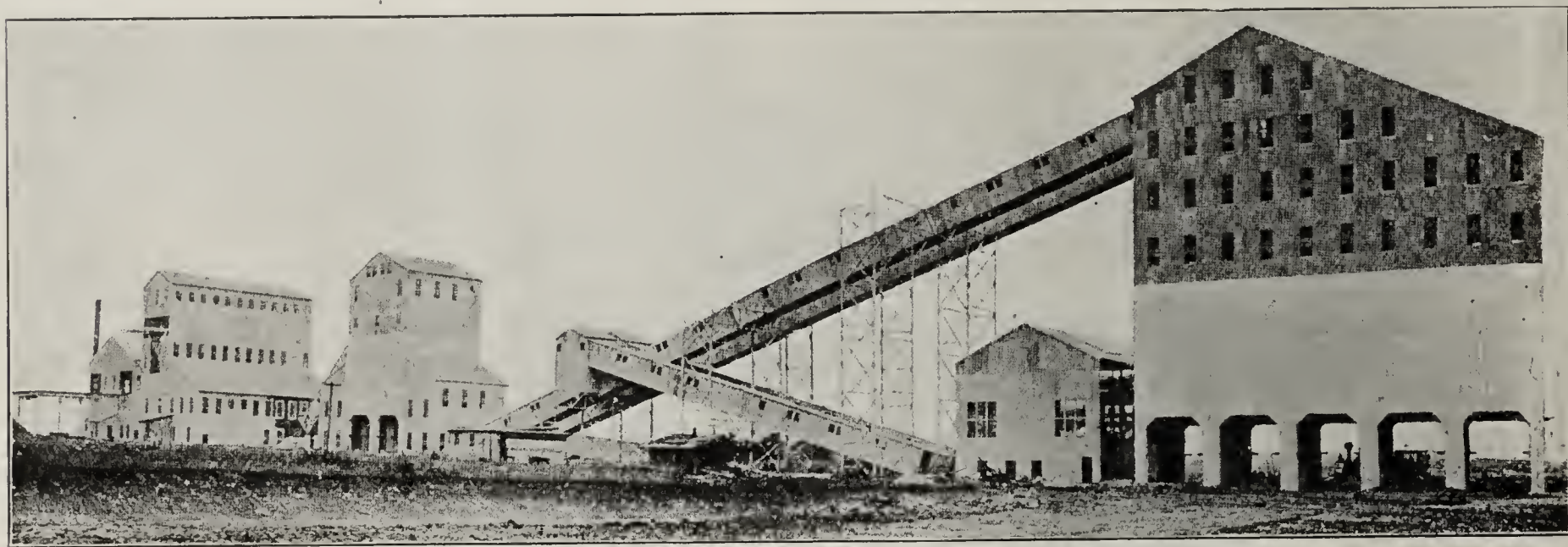
true that the cars have cost the owners almost as much for repairs as they cost new. The experience was necessary, however, to perfect the mechanical features and make the cars strong enough to stand the jolts and wear from this class of work.

The quarry company considers that this experience has proven, in spite of the excess maintenance cost during the first few months, that the system is worth all the money put into it. A brief description of the new cars is as follows: The average weight is 26,300 lbs., and the capacity is 12 cu. yds. Each car is equipped with two 30 h. p. motors using a direct current at 220 volts, and has an automatic brake which controls this speed of the car on down grade and another arrangement which enables the tower man to set the brake. The tower man controls all movements of the cars from a centrally located tower house.

The chief annoyance was the constant breakage of the cast iron cores in the resistance coils placed upon the car for the automatic control of the brake. This caused several smash-ups and the remedy was found in substituting iron wire in place of the cast iron piece. The car was further strengthened by using steel box

transmission line (carrying 33,000 volts) from the Economy Light & Power Co.'s power plant at Joliet, Ill. Provision is also made for connection, in case of emergency, with one of the Commonwealth Edison Co.'s plants, in Chicago. In the sub-station, the current is stepped down from 33,000 to 480 volts with three 750 k. w. transformers supplying three-phase current at 60 cycles to the motors throughout the plant. There is one 400 k. w. and two 200 k. w. Allis-Chalmers' motor-generator sets supplying 220-volt direct current for the electric haulage system. There is also a complete equipment for measuring and recording instruments for indicating the power required in different branches of the work. Each building contains a transformer to step down the 480-volt current to the 120-volt lighting circuit. The entire plant requires about 1,600 h. p.

Crushing Plant.—The crushing and screening plant occupies five buildings which are connected with each other by belt and bucket conveyors. The buildings are of structural steel covered with galvanized corrugated iron. They rest on concrete foundations. Two of them, the No. 9 crusher building and the main screenings house, are built directly over reinforced concrete bins.



View of the reinforced concrete rock crushing plant of the Dolese & Shepard Company, at Gary, Ill. This is the largest rock crushing plant in the world. There is approximately 960 tons of crushers, screens and elevators in this plant, all of which was erected by contract, by Olson Brothers Company, 2418 Bloomingdale Avenue, Chicago, Ill.

beams in place of the channels first used. The bottom of the car was changed from 4-in. to 5-in. planks and the steel plate lining was divided up into sections, held down with T-irons.

The maintenance of the first 25 cars put in service required the time of three men in the repair shop. With the cars now in use the maintenance will not, it is figured, exceed \$5 per month per car. With this system the labor required for bringing stone from quarry to crusher is but one man. The power required for bringing 4,000 cu. yds. of rock to the crusher costs \$22, according to the records.

Automatic Weighing.—Each car is weighed automatically as it passes over the scales and is not required to stop. The number of the shovel which loads the car is also taken at the same time by an automatic arrangement. These figures are stamped on a tape by the machine in the scale house, and the tape figures are sent to the main office each night. In this way an absolutely accurate record is kept of the number of cars loaded by each shovel, each day, of the weight of the material on each car, and of the total for all. By this method deficiencies can easily be located. The cars are dumped by an electrically operated pneumatic lift which is controlled by the tower man.

Electrical Equipment for General Plant.—There is no power house, but the electric current is furnished by a

Each building contains an overhead traveling crane or trolley hoist for handling the machinery in erection or in repair work. The crane and hoist runways extend outside the building over a sidetrack.

The main crusher, a McCully gyratory No. 21, is stated to be the largest made. It has a two-arm spider and its ordinary capacity is about 6,000 cu. yds. of rock in 10 hours, but this can be exceeded by 50 per cent if required. The total weight of the machine is 225 tons. It is driven by a 250 h.p. motor with rope transmission.

The main crusher discharges its product in 6-in. size onto two parallel bucket conveyors. The crusher discharges on both, or on either side as desired. These conveyors elevate the stone on a 45° incline to the top of the next building, and deliver it to a large steel bin from which it is fed automatically to two No. 9 Gates gyratory crushers, each driven by a 100 h.p. motor.

Both crushers deliver their product to two revolving screens. (From these No. 9 Gates crushers the east half only of the plant as planned has been built. The other part will be built during the coming winter. The completed portion of the plant is, however, carrying the full capacity calculated for the entire plant. This means that the present completed part is carrying successfully 100 per cent overload, and the plant has had to be shut down for repairs only 7½ hours since it was

started 8 months ago.) The stone rejected by these screens, $2\frac{1}{2}$ -in. to 4-in. size, is delivered to two elevating bucket conveyors which are driven by 60 h.p. motors. These conveyors elevate the stone on a 45° angle and deliver to the present 4 bins of the flux storage building. All of this stone or a part of it, if required, can be delivered to four No. 6 gyratory crushers (two on each side of the flux storage building). These crushers are driven by a 50 h.p. motor and crush to a $2\frac{1}{2}$ -in. size. This product and the $2\frac{1}{2}$ -in. size from the No. 9 crushers are delivered to two 30-in. belt conveyors which are about 350 ft. long and are on an incline of 23° . Each is operated by a 60 h.p. motor. These belts deliver to the main screen house. This house now contains, four revolving screens 4 ft. in diameter and 28 ft. long, with 16-ft. jackets, four revolving screens 4 ft. in diameter and 24 ft. long, and four shaking screens, 3x12 ft. The two belt conveyors discharge into the 28-ft. revolving screens whose rejections are in turn discharged into the 24-ft. screens which have larger perforations. The stone that passes through the first revolving screens is delivered to the shaking screens, which separate it into smaller sizes and is then passed to the storage bins. The rejections from the revolving screens are delivered by horizontal conveyors to the recrushing rolls house. This house contains two sets of rolls 54 ins. in diameter and 24 ins. wide, having the surfaces fitted with chilled iron corrugated plates of the herring-bone pattern. There are also two sets of rolls, 36x16 ins. for crushing to $\frac{1}{2}$ -in. size or less. Two 100 h.p. motors operate the rolls by belt transmission. Each motor is belted to a shaft to which is belted one set of large rolls and one set of small rolls.

The horizontal conveyors mentioned, were designed especially for this plant. Each consist of a rubber belt to which steel strips 2 ins. wide are fastened crosswise to the belt and bent up on the ends. These are placed side by side and form a rectangular trough. These belts are fitted with speed changing devices, so as to vary the amount of stone delivered to the rolls. The recrushed product is delivered on a return belt to the main belt, and by it again to the screening plant where it passes a second time through the screens.

The general arrangement of the plant is designed so as to make possible its operation in subdivisions, each subdivision being operated in connection with others or shut off as desired according to the required capacity of output. It is also arranged, so that, by use of a belt conveyor any of the bins of the larger sized stone may be emptied and carried to the recrushing plant.

All chutes are lined with vitrified brick and wherever possible at the junctions of chutes, where there is a constant dropping of stone, pockets are made which collect just enough stone to protect the chute from wearing.

The storage bins are at present 10 in number, each being a cylinder 20 ft. in diameter and 32 ft. deep and having a capacity of 400 cu. yds. They are of reinforced concrete with walls 8 ins. thick (12 ins. at points of contact with adjacent bins or the side walls of the building). The bottom of the bins is a 14-in. slab of reinforced concrete which covers the entire area of the building. The bins are supported on heavy square, reinforced concrete columns. Five loading tracks pass under these bins and have a clearance of 22 ft. above the rails. Under the bins for the storage of the 4-in. flux stone are two loading tracks.

Each bin is fitted with a gate for discharge into the cars. These gates are operated by compressed air. The pipes lead to a central point so that a man can operate four gates at a time. A 50-ton car can be loaded in this way in about one minute.

The scales for weighing the loads will eventually be transferred to below the bins. Here the weight of the empty car can be taken automatically and the scale beam set at the weight which equals the capacity of the car. An arrangement will be made to provide an electrical contact which will cause the pneumatic apparatus to close the discharge gates.

This plant can supply stone of any size from rip rap to a fine dust which will pass a 100-mesh sieve. It can also supply stone in mixtures of different sizes, being so mixed as to be made into concrete by simply adding the necessary cement.

Washing Plant.—For the purpose of providing small, clean stone for reinforced concrete work, a washing plant is being constructed. This plant will be located southeast of the storage bins and will be a timber frame structure covered with galvanized iron. Arrangement is made here for washing all sizes of stone from $1\frac{1}{4}$ -in. down to the size of torpedo sand. The material is washed in running water and the product screened as shown in the drawing. The last stage of the washing process is as follows: The fine material and the water finally reach the automatic gravity dump box. The bottom of this box, as shown, slopes down from the receiving end to the dumping pipes. The fine material fills up the triangular section and the water flows out at the spout. When sufficient pressure is exerted by the weight of the material, the diagonal bottom tips on the axle. This lowers the outlet pipes away from the beam and the material flows out through the pipes until enough weight is released to turn the balance in the opposite direction. Then the bottom swings back and the process is repeated.

Maintenance and Depreciation of Plant.—The general plant is, of course, built on modern principles and the design and selection of all machinery is the result of many years of experience. It was intended to build a plant which would be of the greatest efficiency possible with the best machinery obtainable. According to experience the company has estimated the life of the plant at 20 years. That is a 5 per cent annual depreciation on the plant. The maintenance and repairs for the machinery of the crushing plant varies for the different machines. Crushers cost about 5 per cent of their value annually while for the screens and conveyors this cost amounts to 15 per cent. The larger sized stone wears the screens much faster than the smaller. An example of this is shown in the fact that the screens which take the product from the No. 9 crushers, had to be renewed after 6 months' service. They were of $\frac{1}{2}$ -in. material with $3\frac{1}{2}$ -in. holes. The screens in the other part of the plant which handle nothing over $2\frac{1}{2}$ ins., have now been in service 8 months, are of $\frac{3}{8}$ -in. material and show very little wear. All screens when renewed will be of manganese steel.

It is interesting to note in conclusion that there are approximately 960 tons of crushers, screens, and elevators in the plant. This machinery was erected by contract by Olson Bros. & Co., Engineers and Contractors, Chicago, Ill. The cost of erecting this machinery amounted to about \$13,000. The contractor had the use of the cranes in each building and was able, with these, to handle all heavy machinery directly from the cars to the foundations. The cost of placing the heavy crushers ran as low as \$8 per ton and the cost of erecting the lighter machinery, such as belts, etc., ran as high as \$30 per ton.

THE CONCRETE RAILROAD TIE.

In an effort to make more progress in the mighty tie problem of the modern American railroad today, the Santa Fe railway has taken up with vigor the re-

inforced concrete tie experiment, and has witnessed the first signs of success.

In June, 1907, the Santa Fe placed twenty reinforced concrete ties in the main track between Los Angeles and Redonda Junction. In March, 1908, the inspector of track and roadway reported that the ties showed "no indication of deterioration or failure in any way," and in April, 1910, they were reported to be "in first-class condition in every respect." The track on this line is ballasted with gravel and the traffic is heavy.

The tie is reinforced with horizontal steel rods bent up under the rail seats and tied together at intervals with vertical rods, which serve also as web reinforcement. The rail is secured to the tie by spiking into sections of wrought iron pipe set in the concrete. The inside diameter of the pipe used for this purpose is a little less than the greatest dimension of the spike, in order that the spike may cut the metal enough to insure a firm connection.

The length of the section of pipe is made the same as the depth of the tie, and both ends are passed through tie plates and expanded, so as to hold the plates solidly in the surface of the concrete. This construction allows the tie to be used with either face up. It is necessary to use a spike with a head so formed that its under face will conform to the top of the rail base when the spike is partially rotated, for at each redriving the spike should be turned so that its edges will cut an unused portion of the pipe and furnish a new bond. When the surface of the concrete crumbles under the tie plate or the end of the tube becomes too badly worn to hold the spike, the tie may be turned over in the track, thus providing a new surface and an unused portion of pipe to spike into.

The cost of the tie when made in small numbers is given by the inventor at about \$1.30, and it is stated by the same authority that a railway, by using company forces in the making of the ties, could reduce this price by at least 25 cents.

In addition to the installation on the Santa Fe, a slightly modified form of this tie has been installed on all the lines of the Los Angeles Railway Company, but no reports of its performance in this service are as yet available.

The shortage of suitable timber for railroad ties and the constantly increased expense of the same has led many railroad companies to make experiments costing thousands of dollars for the purpose of improving the tie situation.

At this time the Santa Fe is shipping millions of ties from Japan to place under the rails in this western country. Needless to say, this is costing the company millions of dollars every year.

At San Jose experiments with the concrete tie have been made by the Southern Pacific Company and it is said the tests have been very satisfactory.

The day of the concrete railroad tie would seem to be close at hand.

RECENT SALES OF THE KENNEDY CRUSHER

Chalmers & Williams, manufacturers of cement-making machinery and crushers, Commercial Bank Bldg., Chicago, report recent sales of the Kennedy Gyratory Crusher have been made as follows::

- 1—No. 7 $\frac{1}{2}$ to Phelps, Dodge & Co., New York.
- 1—No. 6 to Rinehart & Dennis, Washington, D. C.
- 1—No. 3 to the Frisco Mines & Power Co., Kingman, Arizona.
- 1—No. 5 to Pittsburg Contracting Co., Pittsburg, Penn'a.

CIRCULAR BINS FOR CEMENT STORAGE AT DEWEY, OKLAHOMA.

A 60,000-bbl. reinforced concrete storage and packing plant for cement, of the circular-bin type, has just been completed for the Dewey Portland Cement Company, at Dewey, Okla. This structure is in connection with the company's cement mill and provides storage for aging the cement and sacking facilities. Cement is received from the mill at about ground level and distributed to the various storage bins by elevators and screw conveyors or by-passed directly to the sacking bins.

The structure occupies an area of 75 x 164 ft., and rises to a height of 84 ft. above the foundations. It embraces four circular bins each 32 ft. in diameter and 8 ft. deep. The interspaces between the bins and at one side will also be used for storage. Under the bins to bucket elevators delivering at the top of the conveyors which carry the cement from the circular bins are two tunnels 6 $\frac{1}{2}$ ft. high and 6 ft. wide, containing the screw bins to bucket elevators delivering at the top of the sacking bins. A cupola, containing the conveyors to distribute the incoming cement, surmounts the bins, and is built of reinforced concrete and covered with reinforced concrete slabs.

The soil at the site consists of a stiff clay, upon which a continuous footing slab of heavily reinforced concrete, 4 ft. thick, was laid down to form the foundations. This foundation slab extends beyond the bins 4 ft. to carry the extra load due to the arching action of the cement and its friction on the side walls, bringing much of the load to the walls. Two single flight screw conveyors are placed in the transverse tunnels under the bins, each conveyor serving two bins and the central interspace bin. Two double-flight conveyors delivering into the single-flight conveyors are provided for each circular bin. The double-flight conveyor prevents the cement from flowing unless the screw is turned, and thus acts as a gate. Cement stands at a very flat angle of repose, therefore, the bottom of all the tanks are built flat, as it will rarely be necessary to completely empty the bins.

Two steel discharge spouts in the bottom of the interspace bin feed the cement by gravity into either of the long single-flight conveyors, and are controlled by under-cut gates. A flat slab of reinforced concrete, 18 in. thick, is placed over the tunnels and carries the loading through the 2-ft. side walls to the 2-ft. footings forming the floor of the tunnel.

The walls of the storage bins are 10 in. thick and are reinforced from the bottom to a height of 40 ft. with $\frac{3}{4}$ -in. round rods placed horizontally 3 in. apart on centers, from elevation 40 ft. to elevation 65 ft., the $\frac{3}{4}$ -in. rods are spaced at 4-in. centers. In the balance of the wall to the top of the bins $\frac{3}{4}$ -in. rods spaced at 5-in. centers are used as reinforcement. This is about twice as much steel as is generally used for grain bins of similar design. The vertical reinforcement consists of $\frac{3}{4}$ -in. round rods spaced 2 ft. apart on centers around the bin.

The cupola on top of the bins contains a single-flight screw conveyor, which delivers cement to any one of the four bins or to the central inter-space. Openings in the sides of the central inter-space will permit drawing the cement in it into any one of the adjacent circular bins.

The sacking bins are divided into four compartments by one solid wall and two curtain or tie walls, each 10 in. thick. The tie walls have openings 2 ft. high, the full width of the bins, alternating with the concrete sections 10 ft. high which serve to shorten the front-wall spans. The floor of these bins is at the level of

the top of the sacking room, and the outlets are connected with steel spouts, which deliver to the sacking machines. Over the sacking floor, the front wall of the bins is supported by three concrete columns 18 x 24 in. in section.

Cement can be drawn into the sacking bins directly from the two circular bins and the inter-space bin adjacent thereto through cut-off gates operated from the sacking floor. The sacking floor has a clear space 19 x 42 ft., plus the opening 9 ft. 4 in. wide under the sacking bins. Lift doors are provided at either end and along the side adjacent to the car tracks to give this room as much ventilation as possible. A 41 x 54-ft. reinforced concrete shed extends out over the three switch tracks, which are sufficiently close together to permit the loading of three rows of two cars each, at one time by runways through the doors of the cars on the first and second tracks.

The concrete in the foundation slab and tunnel was made in the proportions of 1 part Dewey Portland cement, 3 parts sand and 6 parts broken stone. The bin walls are of a mixture of 1 part cement, 2½ parts sand and 5 parts gravel. The concrete was mixed quite wet, so that it was readily spaded into place and insured a good face against the iron sheathing of the forms.

The side walls of the storage bins were built as a monolith. The work once started was completed to the top in 20 consecutive days. The forms were so built that they could be raised continuously day and night as the height of the walls increased. This was done in the same manner as the forms of similar design have been used for several years in erecting concrete storage bins for grain. The entire plant was designed and built by the Macdonald Engineering Company, of Chicago.

IMPROVEMENTS IN CONCRETE CONSTRUCTION.

The fact is that concrete construction of all kinds must in the last analysis possess a high degree of fireproof quality and rigidity of form. If either of these qualities are weakened or reduced the standard of concrete buildings must suffer. Concrete is used by so many different kinds of builders and contractors that its abuse is quite common.

Concrete differs from clay as a building material in that it can be employed by builders generally without the equipments, which gives a certain standardization to clay products. The latter are produced by companies who employ only specialists, and consequently there is a uniformity of material, which give standard results. On the other hand, any builder who can afford to buy a few barrels of cement can put up structures of more or less dangerous character.

City building departments have consequently been forced time and again to regulate the use of concrete and to issue specifications governing its mixing and setting. For many years concrete engineers were not in entire agreement as to the best manner of using concrete, and it required long and severe tests to secure the proper data to demonstrate the highest efficiency of certain mixtures.

When we come to reinforced concrete the problem becomes even more complex. In this form of building material we have two scientific factors to consider carefully. The tension and expansion of the reinforcing metal must be considered and also the mixing and setting of the concrete. Ignorance of either one of these factors must eventually lead to disaster. It may not be that a

single mistake in estimating the strength of either will cause a collapse, for often buildings with distinctly weak walls or piers will stand for years without falling. But this is due chiefly to the fact that the load factor has not been severely tested.

Ordinary building laws must specify the nature of the reinforcing material as well as the nature of the concrete mixture. This is particularly true where the material is being used for floors. The danger is that the builders in their effort to economize in the metal reinforcing rods will whittle down the size and strength of the rods to the danger point. They apparently trust too much in the rigidity and strength of the concrete. Hence collapses. Another point of vital importance; very often the metal reinforcements are not properly clothed with concrete, and a small interior fire warps and twists the metal rods. This warping and twisting cracks the concrete and causes disaster. Metal for carrying the load of a building can never be looked upon as a fireproof material. It is too easily affected by the temperature of the air and it can be depended upon only when it is protected by a good covering of concrete.

Reinforced concrete has been subjected to severe and repeated tests, and many of these are still in the process of development. The United States Geological Survey has recently finished the most elaborate of tests. These have been carried out through twelve months of time, so that the relative value of the concrete up to a year after mixing can be determined. A further desire aimed at in these tests was to ascertain the actual value of certain kinds of gravel, granite, limestone and cinders for use in the concrete. The questions of age and consistency of the material in giving strength and stiffness to the walls were matters of prime importance.

Scientific tests of this nature are of the utmost value to city building departments and special commissions. The average man looks with suspicion upon many of the so-called tests. He is afraid that some of those making the tests are interested in the business, and hence there is an inclination to accept the figures with a certain degree of allowance. Official tests by government experts are not subjected to this suspicion and consequently they represent a certain standard for general use.

Specifications for cement users are of the greatest value in helping city building departments to arrive at proper building regulations and also for guiding the builder who may wish to erect a few structures of concrete. The man who wishes a concrete house put up for himself cannot be expected to follow all the technical discussions about the mixing and setting of cement. He must depend upon the builder or architect to supply this information. Similarly the investor who puts his capital in big reinforced concrete houses must depend both upon the builders and the city's building regulations. The chief objects of building concrete houses of any kind or shape are economy, durability and fire protection. The first may be obtained often at the expense of the latter. Cheap concrete houses can be easily planned and erected, but unless the walls and partitions are durable and fireproof the cost in the end is far from cheap.

The best builders of to-day have reached a consensus of opinion that specifications cannot be too rigid in the use of materials and their proper proportions. Columns and other structural parts subjected to high stresses require exceptionally rich mixtures, carefully compounded and set. In the past very often this rule has not been carefully followed, and collapses have resulted. For columns and supporting parts of the structures the proportions should be at least one of cement to one and a half of loose sand and three of loose gravel or broken stone. Anything short of this mixture will reduce the strength and rigidity of columns so that danger is invited. Even

this proportion is not strong enough for high buildings where the load factor is great. It applies to rather low buildings not intended to carry any great load, such as factories and storage warehouses. These latter require particular specifications worked out according to the weight of the load to be carried by the upper floors.

Reinforced floors, beams, columns, and arches in buildings subjected to a good deal of vibration, especially in factories and lofts where machinery is used, require proportions of 1:2:4. That is, one part of cement should be used for every two of loose sand and four of loose gravel or broken stone. Here, too, variations must be made according to the load to be carried. The size and number of the metal rods used for reinforcing are matters that have to be worked out in each individual case.

Concrete machine foundations, retaining walls, abutments, piers, thin foundation walls, building walls, ordinary floors and sewers with heavy walls should have a proportion at least of one of cement to two and a half of loose sand and five of loose gravel or broken stones.

There is finally unimportant work in masses where concrete of a thinner mixture can be used with success. These include foundations supporting stationary loads, heavy walls and the backing of stone masonry. The proportions recommended for this work are 1:3:6. The danger in using concrete for building purposes is that an unscrupulous person will confound the different classes of work and attempt to use the specifications of one for another. Thus, if the lean specification for a stationary foundation should be used for foundations subject to heavy vibrations where machinery is used, there would be a collapse sooner or later. Likewise, if such a mixture should be employed for columns and structural work the building would be unsafe. Reinforced concrete needs also a rather strong mixture, so that the metal rods are held firmly in position and not permitted to bend or change position. The fireproof quality of the walls or beams is the direct proportion to the amount of cement used. Reinforcing rods must be covered with at least several inches of good concrete to protect them from the action of fire.

The quality of the sand and gravel must be considered as well as the proportions and the nature of the cement. Thus, anything which will not pass through a sieve with $\frac{1}{4}$ -inch round holes should be rejected and must be included in the coarser gravel or broken stone. The careful measuring of the different parts is essential to success, and any attempt to use the sand without careful sifting means danger. Cement passes through a chemical process in the course of setting, and it must have the right particles to bind the mass together securely. The ideal concrete is a mixture with just enough cement to cover all particles of sand and stones and fill the voids without an appreciable excess of the binding agent. Thus, too much, as well as too little cement may work evil in any kind of building operations.—The National Builder.

"REINFORCEMENT BARS."

The William B. Hough Co., Chicago has issued a new edition of the pamphlet, "The Bar That Never Failed." The new edition contains 30 pages. The claims of twisted steel reinforcement, of high elastic limit, are stated clearly and the advantages of cold twisting pointed out. Data are given on the efficiency and economy of M-B bars, which is the trade name of the company's twisted reinforcement, and specifications for reinforcing material are suggested. In the latter part of the book are descriptions of the company's built-

up girder frame and "Securo" supporting spacers for spacing and supporting reinforcing bars.

SPOKANE CONCRETE BRIDGE.

The centering for the 281-ft. concrete arch in the new Monroe Street bridge being built across the Spokane River at Spokane, Wash., was wrecked by a windstorm on July 21, causing a loss of approximately \$25,000, in materials and labor. The following details regarding the accident are taken from the report of the city engineer of Spokane, Mr. Morton Macartney, to the Board of Public Works:

The seven ribs comprising the combination wood and iron arches, which were to support the concrete ribs of the span, were in place with the exception of the upper three or four timbers of one rib. These arches had been carefully examined and all of the rods, castings and connections had been inspected and found in good condition, the timbers fitting the castings perfectly, and the entire work done to the plans as prepared.

These ribs were tied together by 12 x 12-in. timbers on the underside of each bottom chord member of the arches and securely bolted thereto. In addition to this there were 3 x 6-in. timbers spiked on each member of the upper chords of the arches besides large numbers of scabs throughout the different timber members of the structure. As nearly as could be determined there was no independent movement on the part of any one rib to indicate that the arches were not secured together in such a way as to form one solid structure. There were securely attached to the upper and lower chords of the outside ribs of this arch 20 $\frac{3}{8}$ -in. and $\frac{5}{8}$ -in. crucible steel cable guys securely anchored in pits sunk in solid rock. The first two ribs of this arch erected caused a sagging on the supporting false work and necessitated the readjusting of the two half members of the same by simply raising them to their proper position, a distance of approximately 1 ft.

The steel cantilever which formerly spanned the river at this point was being dismantled. The suspended span and portions of the cantilever arms had been removed when the storm came, but the structure was not disturbed. The steel structure was entirely free from the timber arch.

At about 1:50 p. m. on July 21 the foreman saw a whirling cloud of dust approaching the bridge from the southwest and immediately called to the men on the structure to get off the bridge. There were only two men working on the wooden arch at the time of the accident. These two men were unable to get off the structure before it fell. They and one other workman were injured, though not seriously.

The timber arch in falling seems to have been twisted by the wind, for the north half of the arch seems to have fallen toward the west, while the south half of the arch fell toward the east. Had the entire span fallen eastward it would have undoubtedly demolished to a much greater extent the power house of the Washington Water Power Company. One corner of this power station was crushed by the falling timbers and some of the controlling apparatus was demolished. The ground wires which were constructed across the river at this point were also broken by the falling timbers.

The cause of the accident, Mr. Macartney states, was due to the high wind and most probably to its whirling condition and instantaneous application to the structure.

The United States weather forecaster officially reports that at about 1:49 p. m. the wind changed from a velocity of 6 miles per hour to 42 miles per hour. He also reports that the temperature at 2 p. m. was 90 deg. and immediately dropped at 2:02 to 59 deg.

CONCRETE'S CONQUEST—A RETROSPECT.

By Frank Soule.

The development, at first gradual, and afterwards rapid, of the multitudinous uses of concrete in construction is an excellent illustration of the law of evolution, or organized progression of the science and art of engineering. Its story shows plainly how every material for constructive use is seized upon and adapted in application so soon as its superiority is proved by test and experience. The ancient Romans used liberally of Roman cement and pozzuolana in their masonry, but chiefly for uniting the massive units in their stone work. As concrete, in our sense of the word, it was seldom, if ever, used by them.

In modern times, the French engineers took the lead in utilizing *béton* (concrete); but less than one hundred years ago, their applications of it were limited to the material in large masses, as, for example, foundations in the earth, sea-walls, and the like; and to situations where only statical forces of compression were to operate. Authorities were doubtful as to the strength and endurance of concrete as compared with those of natural stones, and particularly so when the material was to be subjected to shock, vibrations or transverse stresses. But their ideas and conceptions of the capabilities of concrete grew continually, and their applications of it to construction increased in number and variety. They recognized and appreciated rapidly, as time went on, the wonderful facility of its use in many forms; the great economy involved in the simple processes of gathering raw materials, cement, sand and stone in crude condition, which needed only proper wetting, mixing and shaping in cheap and elementary moulds, followed by final setting, drying and hardening, that would produce the relatively inexpensive and enduring blocks desired.

The art of cement making was greatly developed until the character and behavior of every standard brand came to be as surely predicted as that of steel and iron. The process of wetting and mixing the mass was perfected and the resistances that would be offered by the blocks became well known beforehand.

From the uses of concrete simply in walls, foundations and columns, its applications were extended to arches, piers and highway bridges of short span, where loads were not to be too heavy and vibrations would be moderate.

In our own country at this time, the service of concrete had not, as yet, become generally demanded.

Timber of the best quality was plentiful, cheap and easily wrought, and natural stone or brick was readily obtained. In fact, the "school of design" for concrete construction had not been opened as yet. The material and the best methods of making and using it had not been generally investigated by American engineers, so that for a considerable period of time its employment in construction was limited to river, harbor and sea-coast work, under the charge of officers of the United States corps of engineers.

But our American engineering school of practitioners is wonderfully open-minded, observant and full of adaptability. It quickly came to recognize the supreme merits of concrete as a constructive material, and its readiness for almost universal utilization. The manufacture of cement in America was in consequence vastly stimulated, and its merits greatly improved within a decade. Until within recent years nearly all standard cements in use had been imported from England, Belgium, France and Germany. A present a very large portion of the whole is of domestic origin,

and much of this is of the highest grade. Our engineers, at first doubtful, were gradually converted to a strong belief in its many desirable qualities, those of strength, durability, fire resistance, mouldability and long life in sea-water particularly.

During the early, primitive era of American engineering construction, timber with iron connections for framing, bridge-work, etc.; and brick or natural stone for other structural work were in common use. As manufacturers developed, cast-iron and then wrought-iron and rolled-iron supplanted them in large part, as finally did steel, in great measure. We had thus progressed from ancient days through the stone, timber, iron and steel ages, successively.

Now has come the age of concrete, and especially of "reinforced concrete," of which almost any engineering or architectural structure may very well be built, and which has largely substituted itself for steel. Even girders, simple or continuous, and columns, subject to flexure, are no longer avoided by the designer, if to be built of properly planned reinforced concrete; while arches of it in long spans, with small rise, are in quite general use.

One of the newest applications of this most adaptable material, concrete, occurs in pile work in marine construction or for foundations in yielding soil. In the latter case, timber piling formerly almost universally adopted, is more and more in modern engineering replaced by concrete piling, simple or reinforced, and made either in place, or driven after the completion of the pile. The freedom from danger of decay often occurring in timber is thus secured, as well as a better bond with the superincumbent masonry.

In the case of pile work in sea-water, the greater danger of destruction of timber piles by the action of the "teredo navalis," and the "limnoria terebrans," as well as the decay of the head of the pile by "wet rot," has, in the recent past, been avoided by the thorough creosoting of the timber before its driving; but this is a very expensive process.

A "transition period" from timber piling to the concrete method occurred when a system of timber piles with grillage and platform upon their head was established. The timber work was placed in troughs, dredged in the mud or sand far below their natural surface level, and then afterwards protected by refilling by the dredger, a concrete pier, plain or reinforced having been previously established upon the platform.

The latest development in this line of marine work in our harbors along the Pacific Coast is the concrete pile or pier, plain or reinforced, solid or hollow, sunk, and established at the proper depth, inside a hollow cylinder or other form made of wood; which, in some instances, is removed after the concrete has become mature; and may be used again for another pile. Such piers or piling, properly designed, are worm-proof, have great strength, durability and sufficient flexibility.

The Pacific Coast has an abundant supply of excellent material for timber piling of the best quality; and such method will undoubtedly continue to be used for construction in the less heavy and expensive works in our lakes, fresh or alkaline, and in our rivers; principally on account of its cheapness and ease of handling; but in sea-water, which is always infested with the germs of the teredo and limnoria, the concrete piles and piers will, in the course of time, and especially in constructions of the first class, entirely supplant the other.

Concrete, plain and reinforced, have come to stay, and as fire-proof materials are invaluable. Their practical applications in the arts will continue to increase in numbers for a long time to come.

CEMENT QUESTION REVIEWED BY NEALL.

Direct Attention Again to Alleged Unfair Action of Pennsylvania Railroad.

Frank L. Neall issued a statement on freight rate discrimination yesterday, says the Philadelphia Ledger, as revealed in the loss to Philadelphia of thousands of tons of cement shipments by reason of the lower rates on that commodity from the sources of supply to New York and vicinity. The statement was accompanied by a table exhibiting the distances and rates between the points in the Northampton and Lehigh cement districts and New York harbor and Philadelphia. The statement follows:

"It will be recollected that when this freight discrimination was first brought to the attention of the public much surprise was expressed, as the railroad tariff rates on cement, as generally understood, read:

Freight to New York.....	\$1.40 per ton
Freight to Philadelphia.....	\$1.35 per ton

"As this small differential in favor of Philadelphia was understood to represent the shorter distance actually existing between the cement regions and Philadelphia, as compared to the distance between the cement regions and New York harbor, the difference in freight, though slight, was accepted as probably fair and reasonable.

"It was only when the Government, through the Panama Canal Commission, contracted with a Northampton cement mill for 900,000 tons of cement, to be delivered for shipment to the Panama Canal, that Representative J. Hampton Moore and other Philadelphia interests, when trying to secure some of the cement for shipment via Philadelphia, by reason of the somewhat lower rate of freight understood to prevail here, made known that while the \$1.35 per ton freight to Philadelphia was an absolutely flat rate, the rate to New York, \$1.40 per ton, to such points as Jersey City, Hoboken, Perth Amboy, Elizabethport, etc., was subject to a deduction for normal lighterage of 60 cents per ton, making the actual rates from Northampton to Philadelphia \$1.35 per ton, and from Northampton to New York harbor 80 cents a ton.

Probably four-fifths of the total cement reaching the harbor of New York, for any purposes whatever, is carried at a rate of 80 cents per ton or less. When it was appreciated that the difference in inland freight on this single Panama Canal contract, which was to be manufactured at Northampton, Pa., only 74 miles from Philadelphia, would be \$495,000 more than to carry the cement from Northampton to Jersey City, say 95 miles, the extent and character of the discrimination was better understood.

"It has been pointed out recently to dealers and shippers that there is and has been for years a still lower rate than 80 per cent. on cement from the regions to Hoboken, Jersey City, Perth Amboy, etc. There are three places where cement is manufactured, just over the Pennsylvania State line, in New Jersey, say at Alpha, New Village and Vulcanite, each of which a 75-cent rate per ton on cement to Jersey City, Hoboken, etc., and under which many hundreds of thousands of barrels per year are shipped. This discrimination against Philadelphia shippers and steamship agents was recently pointed out when the steamship Astoria, that brought a cargo of Rotterdam merchandise to Philadelphia after discharging her cargo, proceeded empty to Jersey City to load a cargo of Pennsylvania cement for the Panama Canal Commission, for the single reason that her 6400 tons of cement cargo was taken from Northampton to Jersey City by

the railroads for \$3250, less inland freight, than the railroads would bring it to Philadelphia.

"A number of interested parties pointed out that it was hardly natural to expect shippers and steamship agents to feel as kindly toward railroads in the efforts of the latter to advance inland rates when such unfair conditions were allowed to prevail, as shown in these excessive cement rates charged to Philadelphia.

"As it cannot be successfully disputed that 80 cents per ton freight pays the railroads well for carrying the cement from Northampton, Lehigh regions and vicinity, to Jersey City, Hoboken, etc., it would, under existing conditions, pay them equally well to carry it to Philadelphia for a smaller or lower rate, and that they continue to refuse to do so voluntarily does not tend to increase the feeling of shippers and exporters that they are willing to give Philadelphia fair play and a square deal on this cement trade.

"The case is now before the Interstate Commerce Commission, and there will doubtless be a hearing under the oversight of William A. Glasgow, Jr., who was employed by certain united business organizations of Philadelphia to secure an investigation by the commission. The case is having the watchful care of William B. Irvine, chairman of the Cement Committee, and his special associate, Cyrus Borgner, and the merits of the situation will undoubtedly be fully developed."

Comparison of Rates.

Mills Located at	To Jersey City Hoboken, etc. To Philada. (N. Y. Harbor.)			
	Dist.	Rate.	Dist.	Rate.
	Miles.	Per ton.	Miles.	Per tn.
Allentown, Pa.	90	\$0.80	62	\$1.35
Alpha, N. J.	74	.75	77	1.35
Bath, Pa.	96	.80	69	1.35
Bethlehem, Pa.	84	.....	57	.....
Cementon, Pa.	99	.80	69	1.35
Coplay, Pa.	98	.80	68	1.35
Egypt, Pa.	100	.80	70	1.35
Foglesville, Pa.	105	.80	79	1.35
Lesley, Pa.	101	.80	71	1.35
Nazareth, Pa. ....	.....	.....	83	1.35
New Village, N. J.	77	.75	77	1.35
Northampton, Pa.	95	.80	74	1.35
Ormrod, Pa.	103	.80	73	1.35
Siegfried, Pa.	97	.80	69	1.35
Stockertown, Pa.	86	.80	.....	.....
Vulcanite, N. J.	72	.75	72	1.35
Martin's Creek, Pa.	114	.80	90	*1.35

*If for transshipment by water to foreign countries and to points Wilmington, N. C., and south thereof, on the Atlantic and Gulf coasts, rate is 80 cents per ton, via Pennsylvania Railroad lines only from Martin's

CONCRETE TELEGRAPH POLES.

The Pennsylvania railroad system, in order to provide against timber scarcity, has on the lines west of Pittsburg placed in experimental service a number of concrete telegraph poles through New Brighton, Pa. The construction of the poles has followed a series of elaborate experiments which have been conducted during the past two years.

According to the experiments made so far, it is thought that a concrete telegraph pole will last for many generations, thereby doing away with the frequent renewals necessary with wooden poles. Much importance is also attached to the increased strength of the new poles, which hold the strain of the line, even on curves, without braces.

CONCRETE IN PLACE OF WOODEN PATTERNS.

A novel use of concrete is that reported by Mr. J. L. Gobielle, a speaker at a recent meeting of the Pittsburgh Foundrymen's Association. Mr. Gobielle stated that he had used plain and reinforced concrete patterns with great success and made a large saving over the cost of wooden patterns. He cited one particular instance in which the pattern for a housing priced at a wage cost of \$432.00 was made in reinforced concrete for a total of \$71.60.

In some cases the design was first modelled in clay from which a plaster impression was taken and used for pouring the concrete pattern. In another case where an expensive wooden pattern was destroyed by fire, a casting was used as a model and a new pattern in concrete was obtained for less than ten per cent of the cost of the original. The concrete patterns withstand the jarring action of the molding machines perfectly and are, of course, free from any danger of loss by fire.

TORN SACKS.

A man who repairs torn sacks before returning them to the cement manufacturer has the very best of intentions, but the net result of his efforts is wasted money and needless trouble, says a bulletin of the Universal Portland Cement Co.

If the cloth in a torn sack is sound and strong, and the sack does not bear signs of wilful abuse, we pay full value for it and repair and patch it at our own expense. We have special machines and skilled men to do this work, and when they are through with a repairable sack it is, to all intents and purposes, as good as new.

It is easy to understand the reasons that lead people to mend sacks themselves. Some are still haunted by the old superstition that the cement companies throw out any sack that has a pin hole in it and refuse credit. They believe that by forestalling the cement companies' inspectors and mending these holes themselves, they will get full credit for the sacks; but, as we have already shown, this belief is incorrect. We have found other cases where men will take old sacks that are quite beyond repair and endeavor to build new sacks out of the fragments by laboriously joining and piecing them together. The results of some of this patch work would be amusing if we did not realize that it means trouble and disappointment to customers. Sometimes we receive sacks that have been built up by sewing the top half of a Universal sack to the bottom half of a sack of some other brand. Sometimes we get sacks that have had patches sewed onto them or rips repaired with stitches an inch long; evidently the work of some one who was mending sacks at so much apiece. This kind of mending is manifestly useless, because the cement will flow out between the stitches almost as quickly as it would out of the original hole or rip. Again, we often see cases where some well-meaning but thoughtless person has mended a long rip by laying the two edges of the rip together and running a seam along them. Sometimes so much cloth is consumed in making this seam that the sack is not large enough to hold 95 pounds of cement any more. In the same way, sacks that have had the bottom torn out are mended by doubling the bottom in and resewing it, which is also likely to make a sack that is too small.

One thing against which we wish particularly to caution our customers is the use of glue or cement in mending sacks. We have experimented with glue ourselves and have found that it does not pay. A glued

patch is, at best, a clumsy and unsightly job. It destroys the neat appearance of the package and makes an article that the customer of a retail dealer would hesitate to buy. It has more serious defects than this, however. A glued patch destroys the flexibility of a sack, so that when the empty sack is crumpled up or handled, the patch is almost sure to break or come loose. The tendency of the patch to come loose is increased by the fact that a great many people glue patches onto sacks that are not thoroughly clean, with the result that the glue, instead of sticking to the cloth, sticks to a film of cement dust and does not make a tight mend at all.

When we pass on shipments of returned sacks, we have a double duty to perform. We must be as liberal as possible in order to protect and take care of the interests of our customers. On the other hand, however, we cannot pay for sacks that are unfit for further use, because the practice of paying out something for nothing is unbusinesslike and wrong, and we certainly cannot use sacks that we would be ashamed to send out to some other customer with cement in them. We realize that a tear of ordinary size does not necessarily destroy a sack and, with this in mind, prefer to mend such sacks at our own expense and mend them right, rather than have our customers put to the necessity of doing the mending in order to get credit for their sacks and, perhaps, do a job that would be unsatisfactory to the next man to whom the sacks went, filled with cement.

BAD ROCK AND CONCRETE REJECTED.

The Bureau of Inspection of the Merchants' Association of San Francisco is doing splendid work in keeping tab on municipal construction work.

At the request of the Bureau the Board of Public Works has ordered a thorough examination of the defective concrete in the morgue building of the infirmary, with the result that it was decided that, based on the specifications for this work, the condition of the building warranted its condemnation; and the Board of Works has ordered all the concrete torn out and the work done over.

In addition to the above the inspectors' reports show three attempted breaches of specifications on one of the new school buildings. Rock for the concrete was very dirty, a large percentage of it was soft, and the concrete was being mixed by hand, making a lower value in the cement element, and a lower strength of the aggregate. Complaint was made by the bureau inspector, but the work went right on until the matter was carried up to the president of the Board of Works. In Mr. Casey's office pieces of the rock delivered for this job were taken by the bureau's engineer and knocked to pieces in the hand. A thorough investigation of the whole building has been requested, to include tests of the completed concrete. Samples of this rock have been taken before witnesses and stored under seal in the office of the bureau.

VOLUNTARY ACCIDENT RELIEF PLAN.

The Universal Portland Cement Company has recently adopted a voluntary accident relief plan for the benefit of its employees. Details of the plan are contained in a pamphlet recently issued by the company. The plan of relief adopted by the Universal Company corresponds to one which has been made operative among all the subsidiary companies of the United States Steel Corporation.

NEW CEMENT MILLS.

The Clinchfield Portland Cement Company who are erecting a new plant at Clinchfield, Tenn., was recently incorporated with a capital stock of \$900,000. The officers are: Carl M. Owen, president; E. L. Dunbar, treasurer; Wm. M. Holl, secretary, all of New York.

The United States Steel Corporation has authorized its subsidiary, the Universal Portland Cement Company, to complete at once the construction of Cement Plant No. 6 at Buffington, Ind., to its full capacity of 4,000,000 barrels of Universal Portland cement per annum.

In January, 1910, appropriation was authorized for the construction of the first half of this plant to have a capacity of 2,000,000 barrels, and a decision has now been made to extend the plant to its full ultimate capacity at this time, at a total cost of \$4,500,000. This includes the cost of the power station at Gary, where the electric power to operate the cement plant will be generated, utilizing the waste gases from the blast furnaces.

P. B. Exelby has been engaged as superintendent by the new company. He will have charge of completing the construction and will also conduct the plant after it begins operation.

With the completion of this plant the Universal Portland Cement Company will have, including its present plant at Pittsburg, an annual output of 12,-

000,000 barrels of Universal Portland Cement, all manufactured from blast furnace slag and limestone.

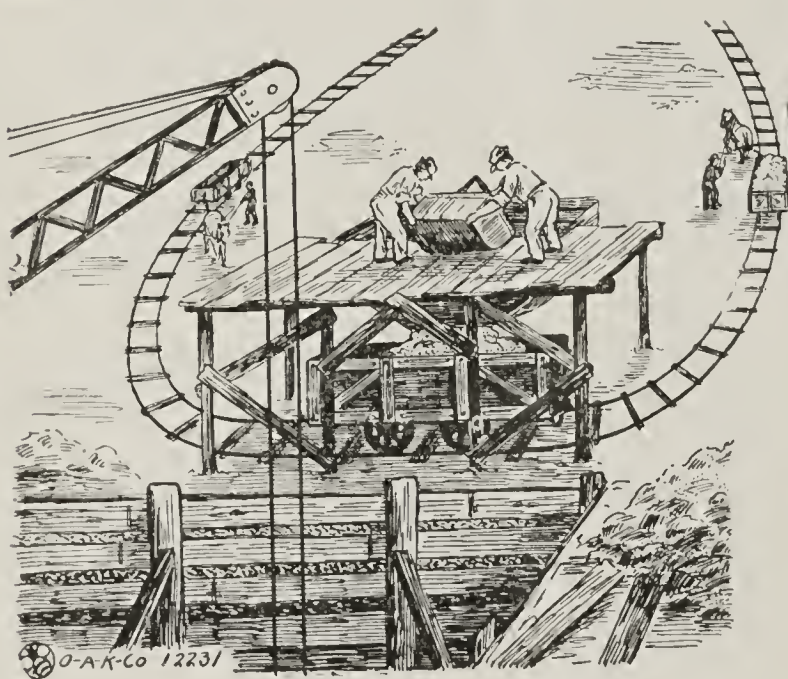
The Piedmont Portland Cement and Lime Company, Austell Bldg., Atlanta, Ga., have started construction work on their new plant at Aragon, Ga. According to reports it is expected to have the plant in operation October 15. The company is capitalized at \$400,000. The initial capacity will be 500 barrels cement per day and 300 barrels lime.

The Yellowstone Portland Cement Co., offices 122 Monroe street, Chicago, are now letting contracts for the machinery for their new cement plant at Yellowstone Park.

The Fort Dodge Portland Cement Corporation, Fort Dodge, Iowa, was recently incorporated under the laws of West Virginia with a capital stock of \$3,500,000. The incorporators are: F. D. Brandenburg, Sioux Falls, S. D.; M. J. Nicholson, H. W. Hinrichs, Rapid City, S. D.; H. S. Van Alstine, F. J. Tischenbanner, Gilmore City, Iowa. The plant will be erected at Gilmore City and Mr. Tischenbanner advises us that it will have a capacity of 5,000 barrels per day. The head offices will be located at Fort Dodge. The company has an unlimited and inexhaustible supply of stone which tests 99.64.

The Gulf States Portland Cement Co., Cleveland, Ohio, was recently incorporated by W. B. Whiting, T. M. Kirby, J. Walworth, Sutphin. Capital, \$10,000.

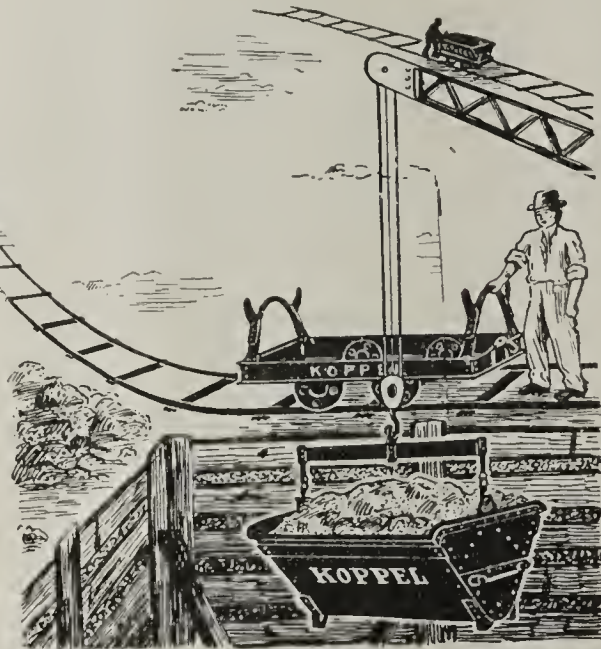
Work will soon start, it is reported, on the new plant of the White Cliffs Portland Cement Co., Little Rock, Ark. The new mill will be located at White Cliffs, Ark., and cost \$1,300,000. The capacity will be 3,000 barrels per day.



WHICH?

method seems quicker and more economical to you? In the cut on the left, earth is taken from shaft in ordinary coal bucket, dumped by two laborers into trap at side, from

whence it is loaded into old-style wooden cars, running underneath trap and hauled by mules. At left,



Koppel Steel Cradle Dump Cars

with crane attachment are used. Beds are lifted from trucks, lowered, loaded, raised, replaced on trucks and cars are easily pushed and dumped by laborers. Thus, no "trap" men are needed and the work is done much quicker.

Write for comparative cost data on how KOPPEL CARS will save money in all contracting and manufacturing works.

ORENSTEIN-ARTHUR KOPPEL COMPANY

General Offices :
PITTSBURG, PA.

New-York

Chicago

Baltimore

Philadelphia,

Boston

San Francisco

Denver

LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GROUND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.,
ALLENTOWN, PA.

Western Office:
725 ROCKEFELLER BUILDING,
CLEVELAND, OHIO.



Economy and Satisfaction Insured When a Jeffrey Conveyer is Installed



We solicit an opportunity to figure on your conveying requirements. Jeffrey Conveyers are designed and built in styles and capacities for any practicable conditions.

We will gladly mail copy of our illustrated Catalog Aa81 to interested parties.

The Jeffrey Manufacturing Company

Columbus, Ohio.



CHICAGO	PITTSBURG
ST. LOUIS	BOSTON
DENVER	NEW YORK
MONTREAL	BIRMINGHAM
CHARLESTON, W. VA.	

ALPHA

PORTLAND CEMENT....

Alpha, N. J.
Works: Martins Creek, Pa.
Manheim, W. Va.
Alsens, N. Y.

Quality unexcelled The Recognized Standard American Brand Always Uniform

ALPHA PORTLAND CEMENT CO.

Manufacturers of but one grade—strictly straight Portland
General Office, EASTON, PA.

Humane Double - Action Trowel

1. Finishes both ways.
2. Does as much work in two hours as a man can do in ten hours the old way, and does it BETTER.
3. Write for prices and literature. Use coupon, postal or letter and address nearest office below.

The Humane Horse Collar Co.

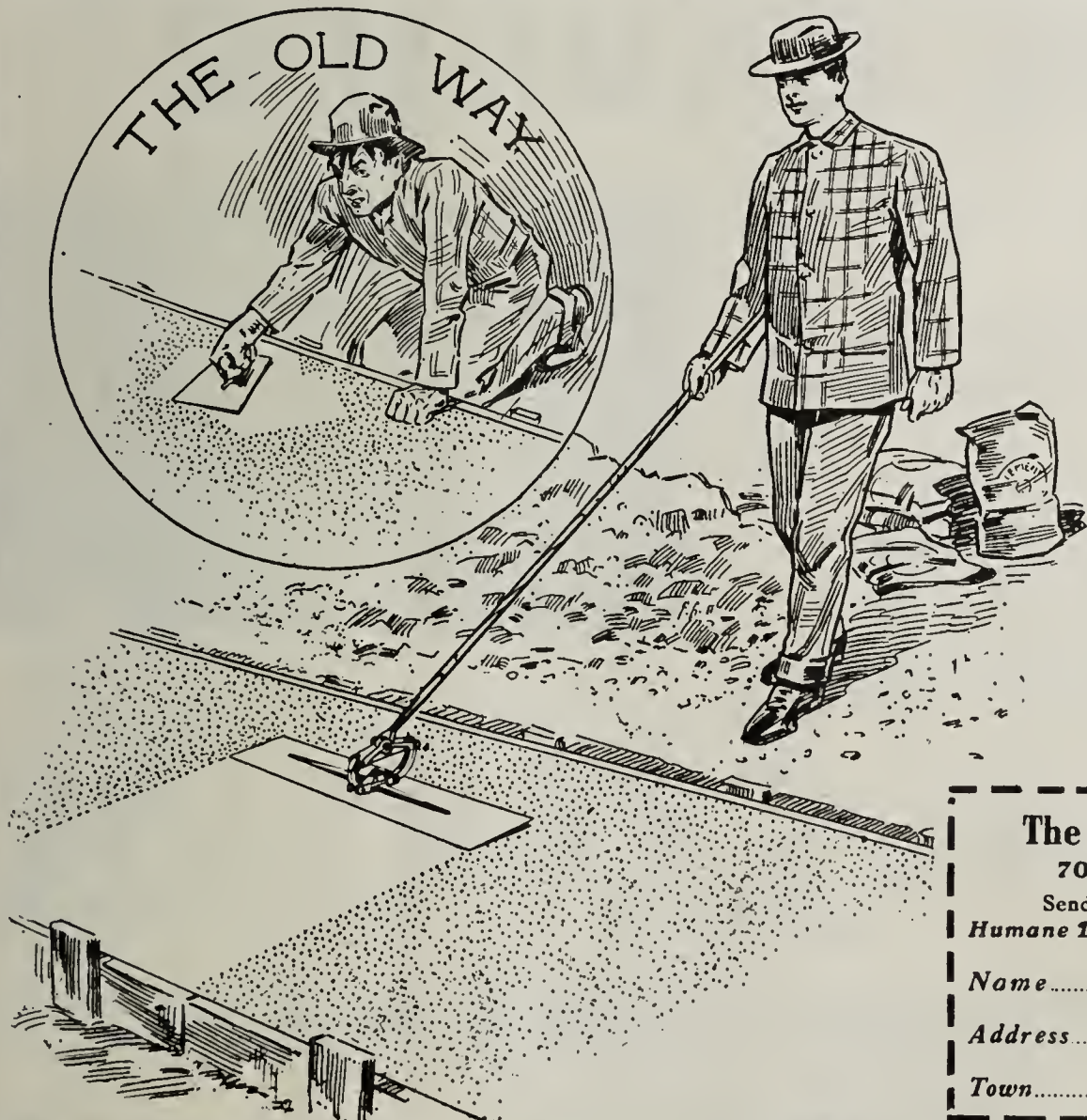
702 Lowe St., Chicago Heights, Ill.

Send me price and all literature on your new
Humane Double-Action Trowel.

Name.....

Address.....

Town..... State.....



The new cement plant which was nearing completion at Chanute, Kans., last year for the Chanute Cement and Clay Products Company when they went into the hands of a receiver will be pushed to completion at once as the company has been reorganized by the bondholders at a meeting held last month. Most of the machinery has been purchased. The following officers have been elected: President, Milo T. Jones, Chanute, Kans.; vice-president and general manager, C. T. Beatty, Chanute; secretary and treasurer, A. N. Allen, Chanute.

When the plant is in full operation in May 1911, it will be the largest single unit manufacturing Portland cement in the world, and with cement plants Nos. 3 and 4 of the Universal Portland Cement Co., which have been in operation for some years at Buffington, will give a total capacity at that point of 8,000,000 barrels per annum.

Construction work will soon commence on the new cement mill to be built at Etiwanda, California, for the Arrowhead Portland Cement Company of Los Angeles, Cal. The capacity of the plant will be about 1,000 barrels per day.

NEW DIRECTORY OF CEMENT MANUFACTURERS.

The Technical Press, Ford Building, Detroit, Mich., have just published a directory of cement manufacturers for 1910. It is bound in leather and contains a list of companies actually in operation, and a list of companies either in course of construction or idle. Also the additional information given of the various companies regarding type of grinding machinery in use.

CONCRETE BUILDINGS A SAVING TO TAX-PAYERS.

Despite the vigorous opposition of various competing interests reinforced concrete bridges are constantly becoming more and more popular. The following quoted from an editorial in the "Oil City (Pa.) Derrick" illustrates the form which the movement is taking in practically all parts of the country: "Readers of the (county) auditors' reports must be struck by the frequency of the item 'repairs to road bridges.' This item of expense is always with us. It is going to remain with us unless we adopt the newer and better style of construction—reinforced concrete. On a well made concrete bridge there are no repairs. There is no biennial painting to save the structure. Flood damages are practically unknown. New floors do not have to be laid at frequent intervals. Once the bridge is built it is there to stay, and the ordinary appropriation for 'repairs to bridges' can be devoted to making the roads better. It is nothing short of extravagance to build any but concrete bridges over the smaller streams, in fact, over any stream where proper approaches and arches are feasible.

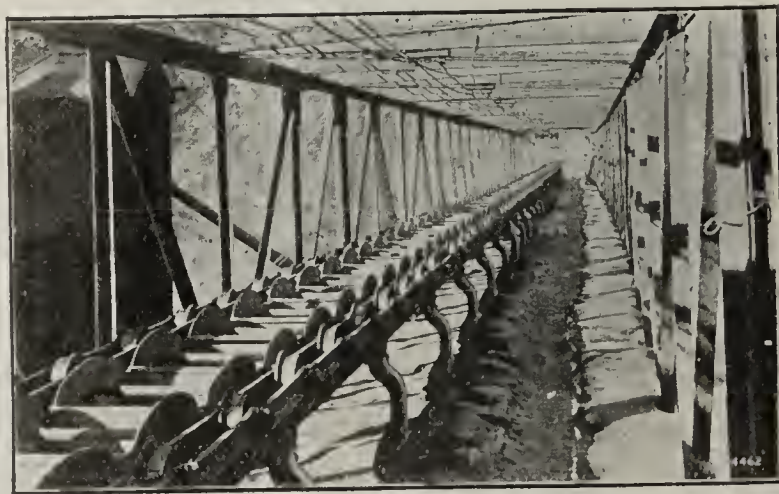
"There is some lingering prejudice against concrete construction of highway bridges because the personal equation is more important in this than in the less durable classes of construction. But it is not difficult to get right men to build the concrete bridges. With that accomplished and a reasonable price paid, the townships, the county and the State can save large amounts of money by building permanent concrete structures."

PECK CARRIER

fits in with Cement Mill requirements because the wear and tear of this service is confined to a few replaceable wear-resisting parts.

The sprocket wheels and rollers for this work are made of our >FLINT-RIM< iron. Durability at Moderate Cost has been our achievement.

We will send our book No. 81 to any cement man in the country—most have been supplied; but to make sure we would like to hear from anyone who is without a copy.



One of five PECK CARRIERS at the Sandusky Portland Cement Works, Dixon, Ill., to handle clinker, coal and rock.

LINK = BELT COMPANY

PHILADELPHIA CHICAGO INDIANAPOLIS

NEW YORK, 299 Broadway

PITTSBURGH, 1501-2 Park Building

ST. LOUIS, Central National Bank Bldg.

SEATTLE, 439-440 New York Block

DENVER, Lindrooth, Shubart & Co.

NEW ORLEANS, Wilmot Mch. Co.

SAN FRANCISCO, Eby Machinery Co.

RAILS! RAILS!! RAILS!!!

New and Second Hand for Track and Building Purposes, cut to any lengths. Delivered to all parts of the United States.

BLOCK POLLAK IRON COMPANY.

Gen'l Offices—First National Bank Bldg., Chicago.

Offices:
Cincinnati, Ohio
St. Louis, Mo.

WE SAVE YOU MONEY.

Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - - 645 No. Sixth St., Terre Haute, Ind.

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

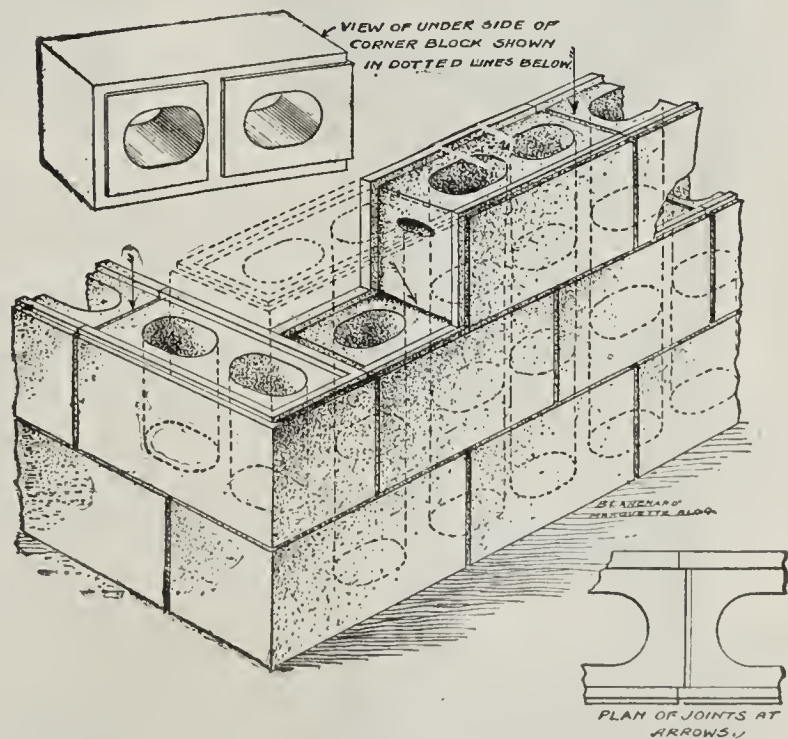
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting
Face-Down Machine by the Wet Process

The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

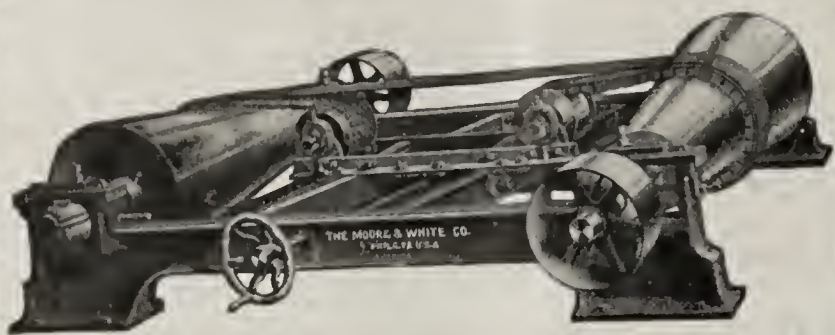
Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and agents wanted in all states and foreign countries.



DIAMOND CONCRETE MACHINERY COMPANY

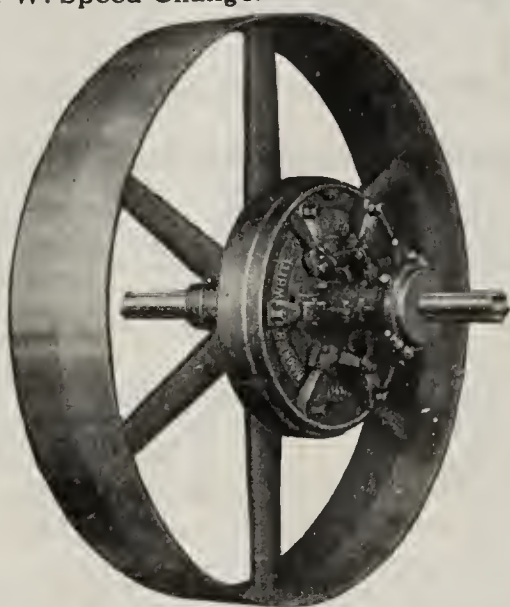
CARDINGTON, OHIO

It will be to any Mill Owner's advantage to investigate these two economical Power devices.



M. & W. Speed Change.

Power
Transmission
Machinery
for
Cement
Mills.



Friction Clutch Pulley.

Write for

Catalogue.

The Moore & White Co.,
Philadelphia, Pa.



SALES

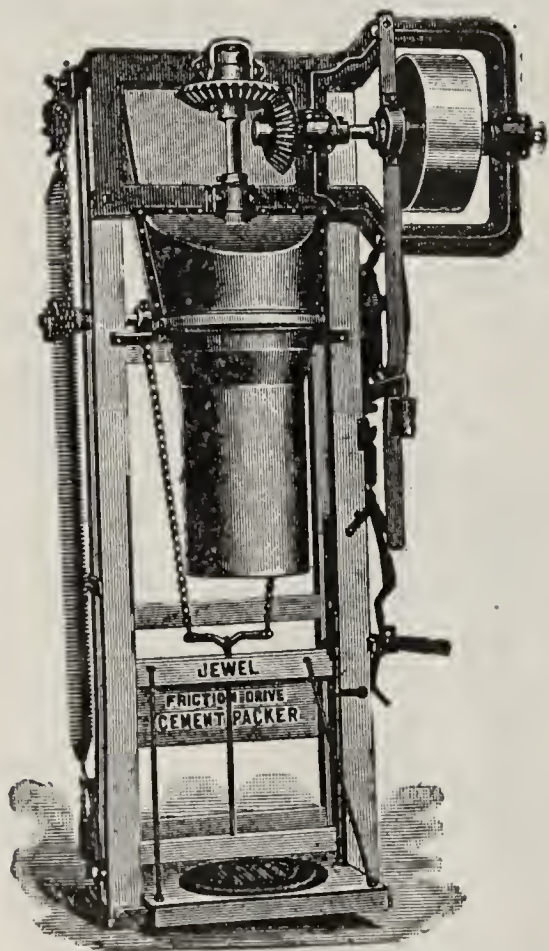
of nearly one-half million barrels of Uni-
versal Portland Cement to one railroad in a single year indicate the satisfaction which Universal gives the engineers of this road in their extensive and varied improvements involving every type of plain and reinforced concrete construction.

Universal Portland Cement Co.

Chicago—Pittsburg

Annual Output 8,000,000 Barrels

There is more Cement being packed by the "S. HOWES" Company's Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and sacks.

The "JEWEL" FRICTION driven cement Packer, specially constructed for rapidly packing sacks.

Both machines are equipped with friction pulleys, heavy iron frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company
SILVER CREEK, N. Y.

Apparatus for Chemical and Physical Testing of Cement

EIMER & AMEND

205-211 Third Avenue, New York City

MANUFACTURERS OF & HEADQUARTERS FOR

Chemical Apparatus, C. P. Chemicals and Reagents

Cement Briquette Moulds.

Gilmore Needle.

Standard Sieves of Exact Meshes.

Williams' Sp. Gr. Balance.

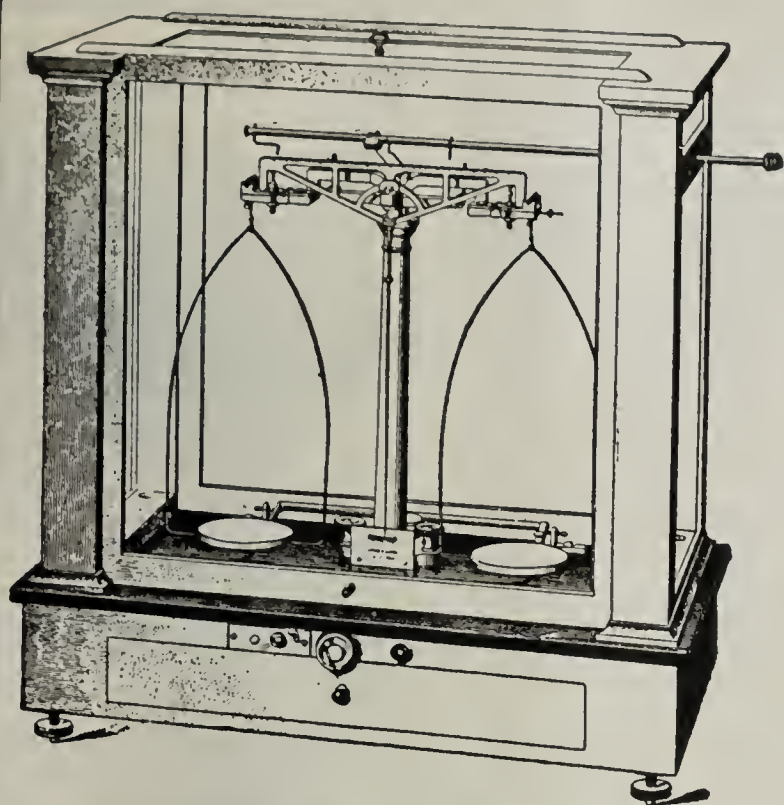
*Specially adapted for determining
Sp. Gr. of Cement.*

(Descriptive Pamphlet sent on request)

*Schumann's, Le Chatelier's,
Jackson's and Candelot's
Apparatus for Sp. Gr. of
Cement.*

Headquarters for **Calorimeters and Pyrometers.**

(Our large illustrated Catalogue gladly sent to Chemists on application.)



F. A. Jones, M. E.

Gypsum Specialist

Consulting Mechanical, and Chemical Engineer, in
Designing Construction, and Operation of Plaster Mills,
Mines, and Mixing Plants.

Plans, Specifications, Estimates of Cost, Superinten-
dence of Construction, ROTARY or KETTLE PROCESS.

Examination, Tests, Analysis, and Reports of Gypsum
Properties, Mills Remodeled and Enlarged, Mixing
Plants Erected, and Formulas Furnished.

883 Mahoning Avenue

YOUNGSTOWN, OHIO

WM. B. SCAIFE & SONS CO.

221 First Ave., Pittsburg, Pa.

WE-FU-GO

and **SCAIFE**

Water Softening, Purifying, and Filtering Systems

— FOR —

BOILER FEED

AND EVERY INDUSTRIAL USE.

Send for Complete Information

DEXTER Portland Cement
THE NEW STANDARD

Sole Agents **SAMUEL H. FRENCH & CO.** Philadelphia



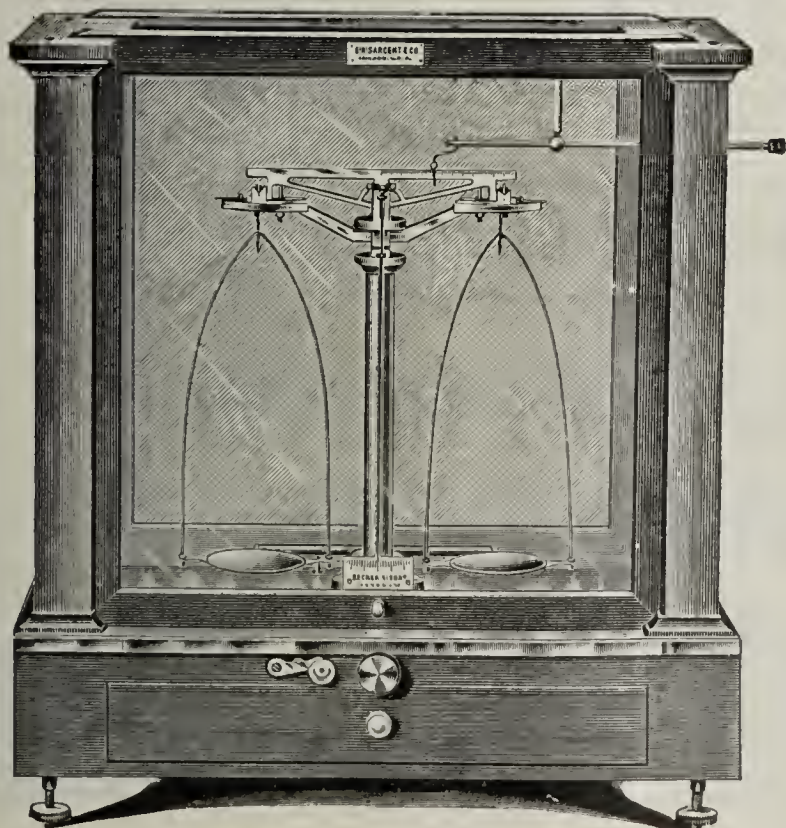
OWL CEMENT

GERMAN AMERICAN
PORTLAND CEMENT WORKS

E. L. COX,

GENERAL SALES AGENT

1527 Marquette Bldg. CHICAGO, ILL.



E. H. SARGENT & CO.

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN

CHEMISTS SUPPLIES

Of high grade only.

We call particular attention to our Cement
Mould, Vicat Indenting Apparatus, as im-
proved by us, Gilmore's Needles, Jackson's
specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

CHICAGO



Medusa White Portland Cement

Used for entire exterior plaster of
Ritz Hotel, San Francisco,
Cal., here illustrated.

A beautiful product adapted to
ornamental artificial stone work
of the highest grade. Equal or
superior to any other White Port-
land Cement known.

Write for free sample, pamphlet
with instructions for use and price.



MEDUSA WATERPROOFING

(Patented Apr. 23, 1907)

Makes concrete impervious to water and prevents ef-
florescence and discoloration. Gives absolutely perma-
nent results and does not affect strength, setting or
color of Portland Cement.

Used by nearly all the foremost Engineers, Architects,
Railways, Contractors, Block Makers and Cement
Experts.

Obtain our price and circular, also price on Medusa
Gray Portland Cement.

SANDUSKY PORTLAND CEMENT Co., Sandusky, O.

"VULCANITE" PORTLAND CEMENT

MAIN OFFICE
Land Title Building
PHILADELPHIA

SALES OFFICE
Flat Iron Building
NEW YORK

PORTLAND CEMENT

WATERPROOFING COMPOUND

Seven Cents per lb. F. O. B. any R. R. Station

We suggest and invite comparison of the unsolicited test reports of cement treated
with our product to those of all others combined.

We Loan Free of Charge a Simple Mixing Machine.

McCORMICK WATERPROOF PORTLAND CEMENT CO.

BANK OF COMMERCE BLDG., ST. LOUIS, MO.

(HIGH CLASS TRAVELING REPRESENTATIVES WANTED.)

The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa

GENERAL MANAGER—CEMENT MILL

Executive Officer, formerly with Portland Cement Company, desires connection with operating or organizing company. Experienced in manufacture, sales or finances. Information and references furnished on request. Address M. H. P., 50 Wellington Court, Brooklyn, N. Y.

POSITION WANTED.

General Superintendent and Chief Chemist, experienced in wet and dry process. Now operating large dry process mill, are open for engagement. Address Box 35., care Cement & Engineering News.

WANTED.

Two cement burners for plant in the East, 25 cents per hour. Address J. N. K., care Cement & Engineering News, Chicago, Ill.

WANTED.

If you are interested in pumps of latest and best styles, send to us for book and catalogue. Pumps of all styles and for all uses. The Columbus Steam Pump Works, West Broad street, Columbus, Ohio.

WANTED.

An experienced cement burner. Dry process. Kilns 100 x 8 ft. Write us stating experience and wages wanted and how soon can come. Address Rocky Mountains Cement Co, Blairmore, Alberta, Canada.

WANTED.

Position as Supt. of cement mill. Have had 20 years experience in designing, building, and manufacturing in the East and West. Am familiar with every trade and branch of operating, from the quarry to finished cement in cars. Also with coal, and oil as fuel. Address O. H. W., care Cement & Eng. News.

Position wanted by an experienced chemist. Eight years experience in cement and other metallurgical lines. College graduate. Best of references from all employers. Address "Benedict" care Cement & Engineering News.

WANTED.

—in sixty days—a first class experienced chemist. Two experienced burners. A good superintendent. Address Piedmont Portland Cement & Lime Co., Aragon, Ga.

Position wanted by an experienced concrete man as superintendent or manager of a concrete block, pipe or tile plant. Expert in installing steam curing plants for concrete product factories. Can furnish best of references. Eleven years experience. Address P. S. F., care Cement & Engineering News.

Chemist with three years experience in Cement Plant as Chemist and Chief Chemist desires position with Cement Company. Graduate of Mass. Inst. of Tech. Address Chief Chemist., care Cement & Engineering News.

WANTED.

Cement mill repair men for plant in the East, experienced ones only need apply. Must be sober and willing workers. 25 and 30 cents an hour. Address E. O. C., care Cement & Eng. News.

Iron-Ore Cement

The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in place of Portland cement for all Marine Construction.

Send for Literature, Etc.

WORM-COX COMPANY

SOLE AGENTS

Marquette Building, Chicago

Fire Brick Linings For Cement Kilns

STANDARD TESTING SAND AND
GENERAL BUILDING SUPPLIES

Garden City Sand Co.,
188 Madison St., Chicago

WANTED.

General Mill Foreman, capable of handling Kent and Fuller Mills. Apply, The Engineering Agency, Inc., 1622 Monadnock Block, Chicago.

TELEGRAPHY.

Learn Wireless and R. R. Telegraphy. Shortage of fully 10,000 Operators on account of 8-hour law and extensive "wireless" developments. We operate under direct supervision of Telegraph Officials and positively place all students, when qualified. Write for catalogue. Nat'l Telegraph Inst., Cincinnati, Philadelphia, Memphis, Davenport, Ia., Columbia, S. C., Portland, Ore.

Peerless Portland Cement

MANUFACTURED AT UNION
CITY, MICH.

Every Barrel Guaranteed

Fineness, Uniformity of Color
and Sand Carrying Qualities
equal to any Portland Cement Manufactured

The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker
1½ inches diameter from the kiln
and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

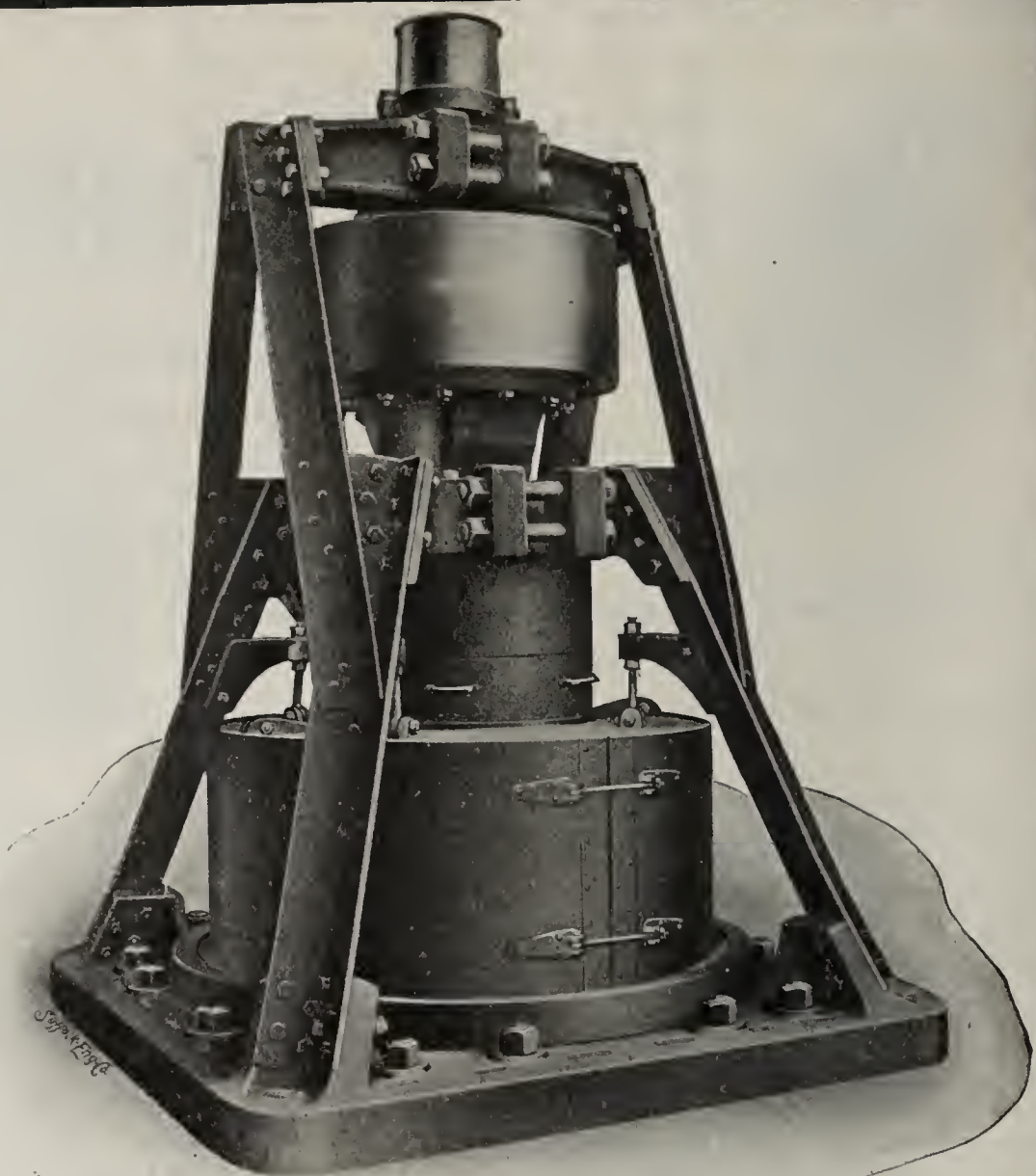
It saves cost in attention.

MANUFACTURED BY

BRADLEY PULVERIZER CO.

37 Walbrook
LONDON, E. C.

92 State Street
BOSTON



Hess Furnaces



No. 45

**"Leader" Hess
Steel Furnace**

Price \$49.00

Delivered East of Omaha and
North of Ohio River
Pipes and Registers Extra

for the past 7 years, have been
sent to customers in every state
in the Union, freight prepaid,

On Approval

and the money held back till
sixty winter days of actual trial
have proved that all our claims
for superiority have been fulfilled.

Isn't this worth looking into? Could
we offer such liberal terms if we didn't
know that the Hess Furnace excels in
service, simplicity, efficiency, economy?

All we ask of you, if you need a furnace, is to investigate—to put your name on a postal card, mail to us and ask us for our booklet "Modern Furnace Heating." This booklet is an authority on furnace heating, and copies have been requested by many colleges, libraries, etc., for reference in engineering and mechanical courses. It instructs fully in the principles and practice of furnace heating, and should be in the hands of every builder and house owner. It is free on request.

In Buying Direct

**From Our Factory You Pay Only
One Profit—A Small, Factory Profit.**

Our prices are not inflated with the usual cost for salesmen, branch stores, agents' and dealers' profits. The factory profit only, satisfies us, and you will be surprised at how much we can save you.

Special Heating Plan Free Before You Order

Let us have our experts prepare a special plan for heating your building. It will cost you nothing, and put you under no obligation to buy of us. Our thirty-six years of experience in designing heating equipments makes this free plan valuable to you.

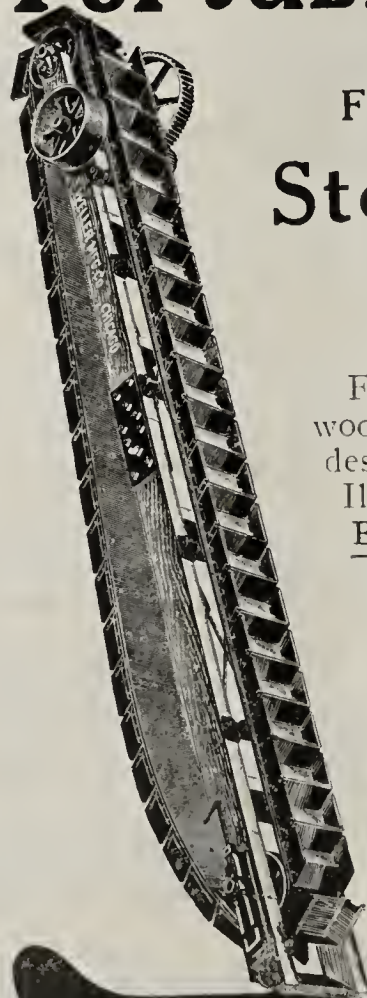
Ask us more about it. A postal card today will serve the purpose.

Hess Warming & Ventilating Co.
919 Tacoma Bld., Chicago.

Portable Elevators

FOR HANDLING

**Stone, Gravel
and Cement**



Furnished in all designs, with
wood or iron frames, and of any
desired capacity.

Illustration shows a WELLER-Made Portable crushed stone elevator; we furnish these for handling all classes of materials.

Send for 512 page catalog
on WELLER-Made Elevating,
Conveying and Power
Transmitting Machinery.

Weller Mfg. Co.

CHICAGO

WELLER-Made

THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

Design, Construction, Remodeling and Operation
of Portland Cement Plants

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street
New YorkCanadian Express Bldg.,
Montreal, Can.1121 The Rookery
Chicago425 Washington St.
San Francisco, Cal.Monongahela Bank Bldg.
PittsburghSyndicate Trust Bldg.,
St. Louis, Mo.Norfolk House, Cannon St.
E. C., London

The Osborn Engineering Co. Civil, Mechanical and Electrical Engineers

OSBORN BUILDING, CLEVELAND, O.

Experts in the Designing of

CEMENT PLANTS.

Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of Cement Machinery

42 NORTH 16TH STREET



PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

COMMERCE BLDG.,
Kansas City, Mo.

Cement Engineers

Just Out!

Architects' and Engineers' Hand Book on
Reinforced Concrete
Construction

ONLY ONE DOLLAR

CEMENT & ENGINEERING NEWS

22 Fifth Avenue, - - Chicago

COLONIAL TRUST AND SAVINGS BANK

205 La Salle Street, CHICAGO

Capital and Surplus \$1,100,000.00

We are offering High Grade Seasoned 5 to 6% Bonds at attractive prices.

Particulars upon Application



THE IMPROVED DIETRICH'S CLAMP

and Form System for Hollow Walls

By the use of the Improved Dietrichs Clamp and Form System for Hollow Walls the

COST OF CONCRETE CONSTRUCTION IS REDUCED 50%

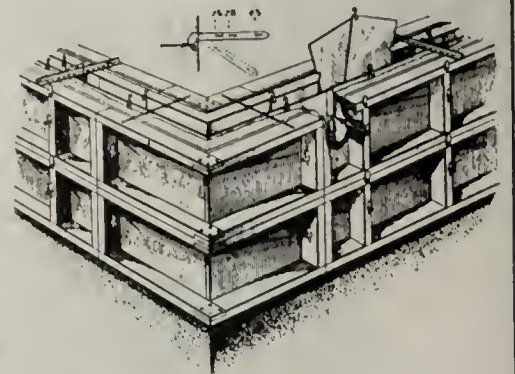
and the builder also secures a

PERFECT DAMP-PROOF WALL

This system is based on the panel principle and employs removable sheet iron inner forms with sheet iron spacer. Corners, doors and window openings are provided for.

Write for pamphlet giving full information

DIETRICH'S CLAMP CO.
LITTLE FERRY, N. J.



ELEVATING—CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys, Shafting, Shaft Bearings, Link Belting, Special Chains



HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES.
Catalog for the asking.

SKILLIN & RICHARDS MFG. CO., CHICAGO



OUR POLE DERRICK is built light and strong. Average length 18 ft.; weight 200 lbs.; capacity 1800 lbs.; equipped with 100 ft. cable block and rollers ready for use \$26.50 F. O. B. Chicago.

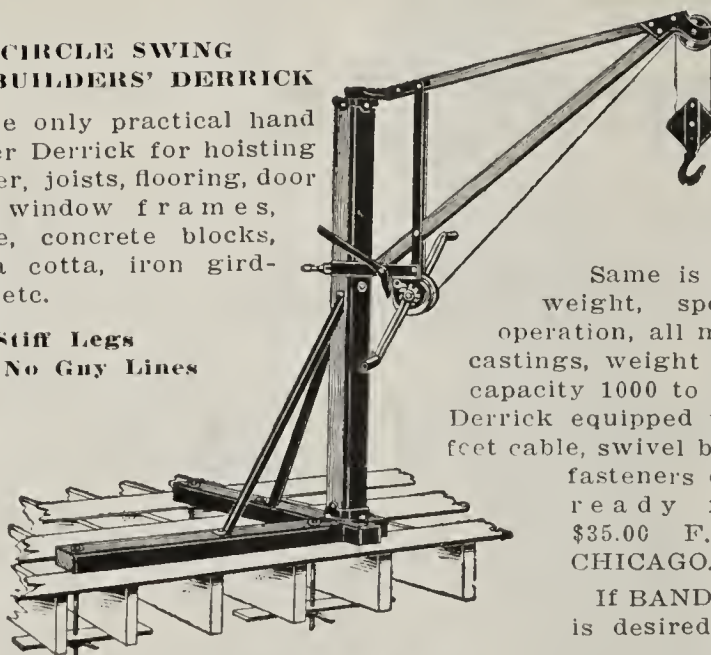
THE SASGEN BUILDERS' DERRICK

The Latest Inventions in
HOISTING APPARATUS

Our CIRCLE SWING BUILDERS' DERRICK

is the only practical hand power Derrick for hoisting timber, joists, flooring, door and window frames, stone, concrete blocks, terra cotta, iron girders, etc.

No Stiff Legs
No Guy Lines



Same is light in weight, speedy in operation, all malleable castings, weight 250 lbs.; capacity 1000 to 1500 lbs. Derrick equipped with 110 feet cable, swivel block and fasteners complete ready for use \$35.00 F. O. B. CHICAGO.

If BAND BRAKE is desired, add \$1

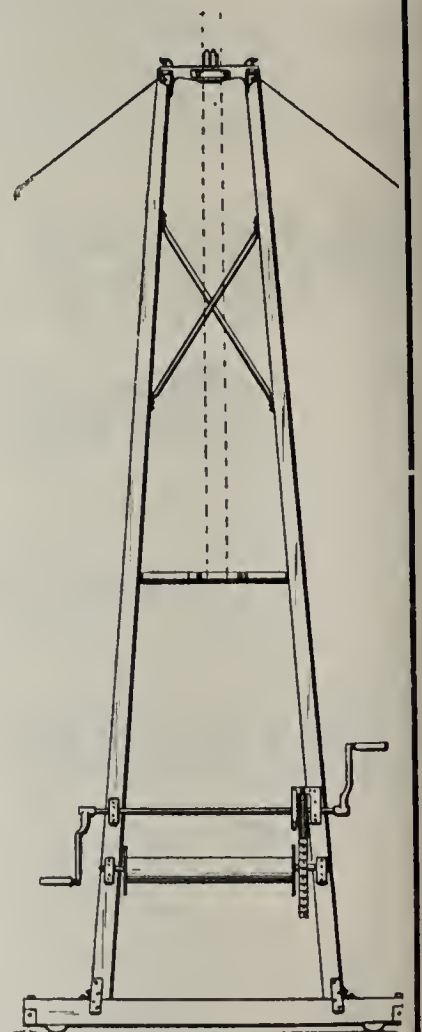
We keep all these machines in stock and can fill orders promptly.

SASGEN BROS.

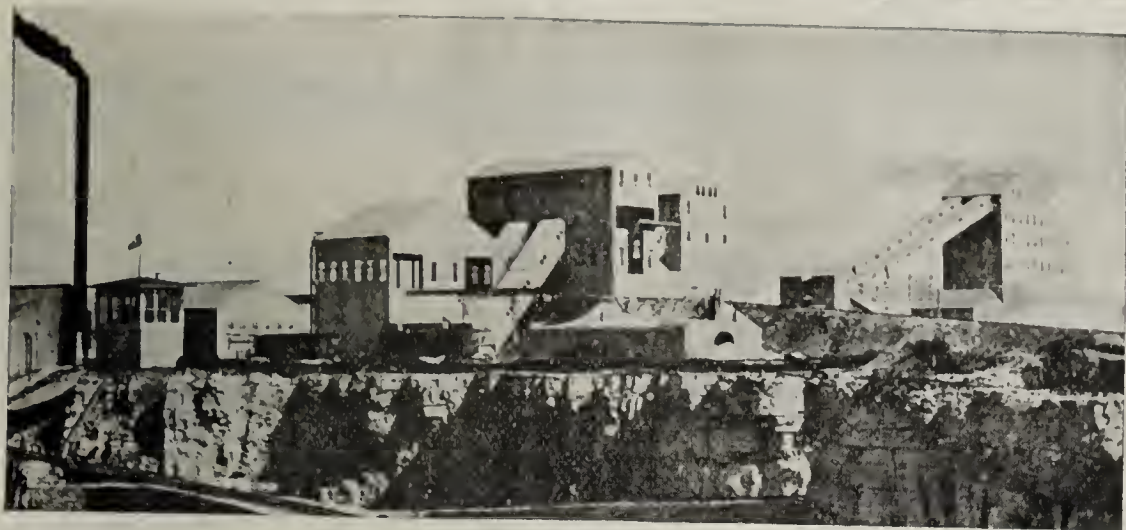
2053-57 Racine Ave., - - - CHICAGO, ILL.

New York Office, 103 Park Ave.

Write for Illustrated Catalogue "C"



OUR SASGEN IMPROVED SETTER DERRICK including a top shive frame, extension clamps, etc Price of 20 ft. lengths \$42.00 F. O. B. Chicago.



Dolse & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world. Machinery throughout installed by us.

OLSON BROS. & CO.

Engineers and Contractors

Cement Mill Machinery Erected, Stone Crushing
Plants Equipped and Erected. :: :: ::

ALSO COMPLETE PLANTS FOR HANDLING
COAL, SAND, GRAVEL, ORES, ASHES, ETC.

MODERN POWER TRANSMISSION
Elevating and Conveying Machinery.

Tanks and Vats, Especially in Connection with Machinery

2418-22 Bloomingdale Ave., Chicago

THE PERFECTION CONCRETE MIXER

A Perfect Feed==A Thorough Mix

"We have three Perfection Concrete Mixers and they do the work in fine shape. I do not know of a mixer on the market that will do the work for the same money."

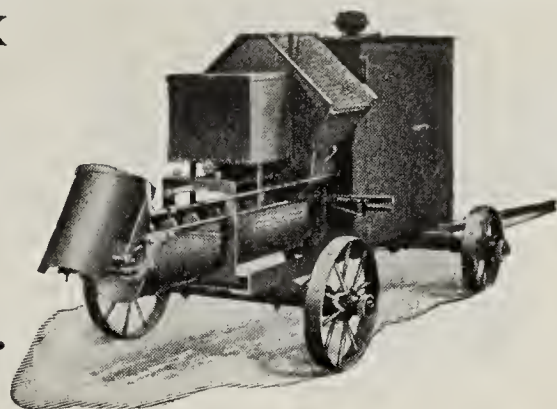
NEWELL CEMENT TILE CO.
Newell, Iowa

We have a 32-page catalog awaiting your request. It is absolutely free, shall we send it?

THE CEMENT TILE MACHINERY COMPANY.

RATH STREET

WATERLOO, IOWA



JUST A REMINDER

ATLAS DRYERS-DRY NEARLY EVERYTHING

THE ATLAS DRYER CO., CLEVELAND, OHIO

"EXPENSES DIMINISHED"

"MEANS PROFITS INCREASED"



ROCK CRUSHERS.

1-9 x 15 Allis Chalmers Jaw Crusher.

ROCK DRILLS.

6-Ingersoll-Sargeant Rock Drills, size 3 1/4 inches.

6-Ingersoll-Sargeant Rock Drills, size 3 1/2 inches.

Fitted for steam or air.

HOISTING ENGINES.

1-12x16 double cylinder, heavy duty LIDGERWOOD hoisting engine.

1-6x8 Marine Iron Works double cylinder, single drums, reversible in steam chest.

PUMPS.

3-24 inch Centrifugal pumps, 2 to 3,000,000 gallons capacity.

1-20x13x12 Wheeler & Tappen Duplex Pump.

IRON PIPE.

70,000 ft. 1 inch Standard Pipe, 35,000 ft. 1 1/4 inch Casing.

50,000 ft. 1 1/2 inch Standard Pipe, 40,000 ft. 3/4 inch Casing.

30,000 ft. 2 inch Standard Pipe, 60,000 ft. 3/4 inch Casing.

2,000 ft. 10 inch Standard Pipe, 8,000 ft. 5 1/2 inch Casing.

4,000 ft. 12 inch Standard Pipe, 9,000 ft. 6 1/4 inch Casing.

30,000 ft. 8 inch Cast Iron Pipe, 1,000 ft. 6 5/8 inch Casing.

300 ft. 24 inch Cast Iron Pipe, 1,250 ft. 8 1/4 inch Casing.

1,500 ft. Riveted Steel Pipe, 24 inch to 72 inch diameter.

ROOFING MATERIAL.

The latest and most modern product ever offered to the public. Our "Raw Hide Rubber Roofing" is without equal in durability and price. Will outlast the kind you have been using from 10 to 15 years and will cost you less. Is fire and weather proof. Send for our special book No. 180 on roofing; tells you all about it.

A CAREFUL COMPARISON OF OUR STOCK AND PRICES WILL DEMONSTRATE A SAVING TO YOU OF FROM 30 TO 75%.

SEND YOUR INQUIRY TO-DAY.

TANKS.

12-1,000 gallon capacity tanks.

42-1,500 gallon capacity tanks.

6-3,000 gallon capacity tanks.

15-3,600 gallon capacity tanks.

2-3,800 gallon capacity tanks.

STEEL STORAGE TANKS.

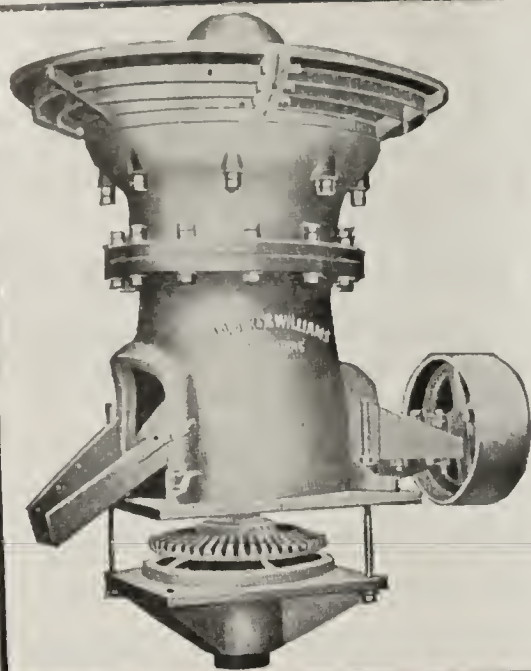
Capacity, 4,500 to 6,500 gallons. These tanks were used only a short time in railroad service. Very heavy construction—1/4" steel with 5-16" heads; domes in proportion to size of tank, and fitted with 15" screwed manhole. We will give them rigid inspection and paint before shipment. Prompt shipment can be made from points South, East and West.

5,000 rolls rubber, leather and canvas belting, structural iron, shafting, pulleys, couplings, steel wire and manila rope. Smoke stacks, corrugated roofing and siding, hose hydrants, tanks. We can save you money on anything you require.

SEND FOR OUR NEW 500-PAGE CATALOG NO. 962.

A wonderful book of facts and information of the utmost value to everyone. Send to-day. It will cost you nothing.

CHICAGO HOUSE WRECKING CO., 35th and Iron Sts., CHICAGO, ILL.



Kennedy Gyratory Crusher

The only Crusher built with a ball and socket eccentric which will lend itself to any change in the inclination of the main shaft. Improved hopper, more efficient dust collars.

— ALSO —

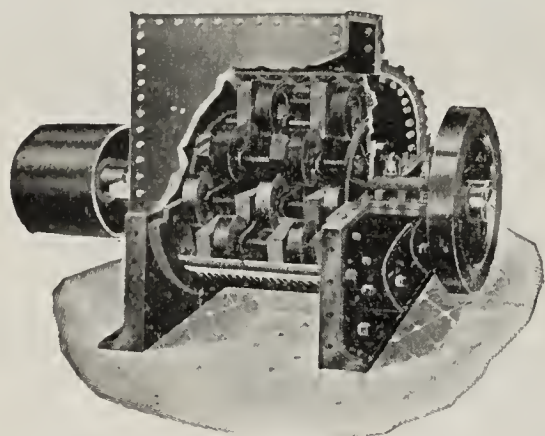
Cement Making Machinery

Kilns, Dryers, Tube Mills, Ball Mills, Elevators, Conveyors, Feeders, Revolving Screens and Crushing Rolls.

Chalmers & Williams Inc.

1927 Commercial National Bank Building, - - - Chicago
120 Liberty Street, New York

American Ring-Hammer Pulverizer



Six Sizes.

will pulverize

Cement, Clinker, Shale, Limestone, Coal, Etc.

30 days' working test at your works allowed. Machines guaranteed.
All Grinding Parts Made of MANGANESE STEEL.

Write for particulars and circulars.

AMERICAN PULVERIZER CO.

410 JACCARD BUILDING

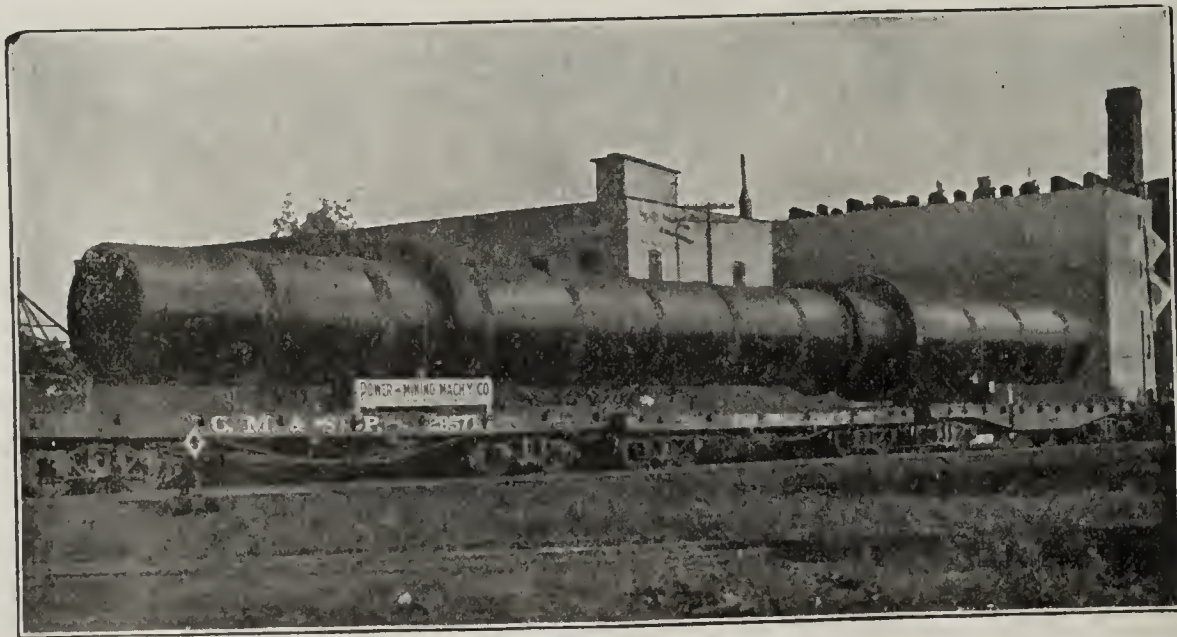


ST. LOUIS, MO.

Cement Mill Machinery

A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process.

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



Write for Catalogue No. 17.

Power & Mining Machinery Company

MILWAUKEE, WIS., U. S. A.

CHICAGO.

NEW YORK.

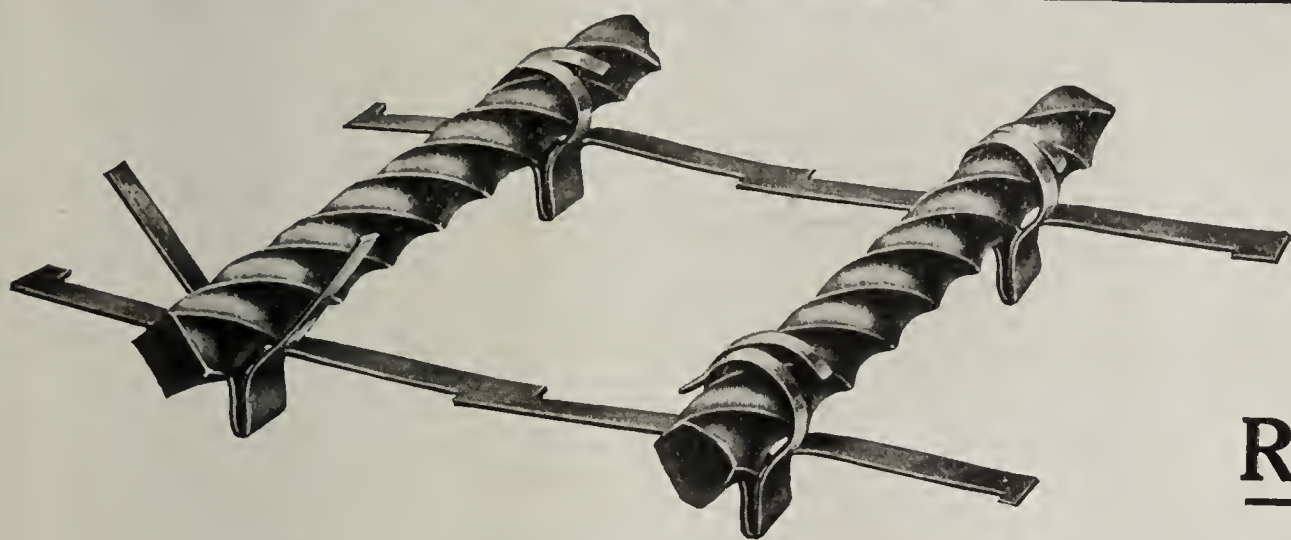
ATLANTA.

EL PASO.

SAN FRANCISCO.



Securo Supporting Spacer



For Spacing
Supporting
and Locking
Reinforcing Bars

A SOURCE of great trouble and expense to contractors and of much concern to architects and engineers has been the lack of any adequate means of holding the slab reinforcing bars the correct distances from the forms, of locating them accurately and of preventing them from slipping and becoming dislocated after wiring.

Present methods involve a great deal of hand labor which is expensive and results obtained are not at all reliable.

The advent of the Securo Supporting Spacer will be welcomed everywhere by engineers, architects and contractors because it is something which has been urgently needed.

The Securo Supporting Spacer accomplishes three distinct things:

- 1—It holds the bar in position at the correct distance from the bottom of the slab, and is, therefore, a **SUPPORTER**—
- 2—It locates the bars evenly and accurately at the specified distances from center to center, and is, therefore, a **SPACER**—
- 3—The prongs of the *Securo Supporting Spacer* when bent over the bar clasp it in a vise-like grip, leaving positively no chance for slipping or sliding, and it is, therefore, a **LOCK**.

By insisting upon the use of the **Securo Supporting Spacer**, the engineer or architect responsible for the building has the satisfaction of knowing that the reinforcing bars are in the exact places called for by the design; the owner is reassured in the knowledge that his building consequently is fully as strong and safe as indicated in the original plans; and the contractor is enabled to have the bars placed with great economy of time, labor and money.

The cost of spacing the bars and locking them in position is less than half the cost of the present method of wiring.

Once set and locked the bars cannot be displaced by the pouring of concrete into the forms, or by laborers walking on the bars after placing.

The **Securo Supporting Spacer** is made of soft steel. The prongs which lock the bars in place are easily and quick

ly bent with a great deal less time and labor than are required for wiring and with absolute certainty of results.

Supplied in several lengths with prongs for spacing at any distances from center to center of bars as called for in the specifications.

The **Securo Supporting Spacer** is never sold through agents but can be purchased only of the William B. Hough Company.

Large quantities of the usual spacings carried in Chicago stock for quick delivery.

Send us a list of your requirements and we will quote prices.

This is only one of the many things you have been looking for which is described in our booklet "*Metal Materials for Modern Buildings*" sent free on request.

WILLIAM B. HOUGH COMPANY

"Where the Reliable Reinforcing Steel Comes From"

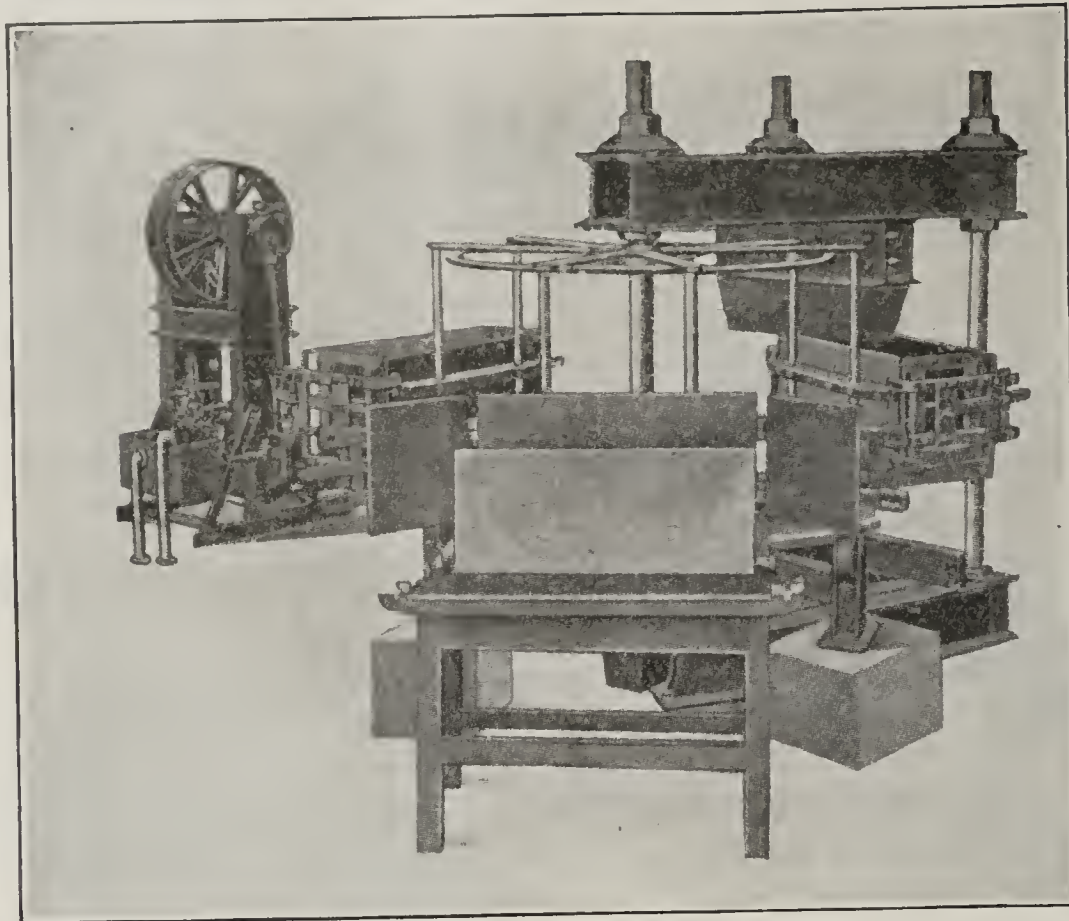
Home Office: Chicago, Illinois.

Detroit :: Minneapolis

Indianapolis :: Des Moines



A DENSE CONCRETE



A Hydraulic Ram Pounding Concrete Into Blocks

TWO MEN do the work. From 1000 to 2000 blocks per day. Three quick-acting mold boxes rotating over the Ram on a Revolving Table, one being filled, one receiving the pounding, one delivering the finished block.

The Fisher Hydraulic Machine pounds a wet mixed mortar together with a Hydraulic Ram and produces a dense concrete with less than 5% absorption, with a high crushing strength, in any style to suit the demand.

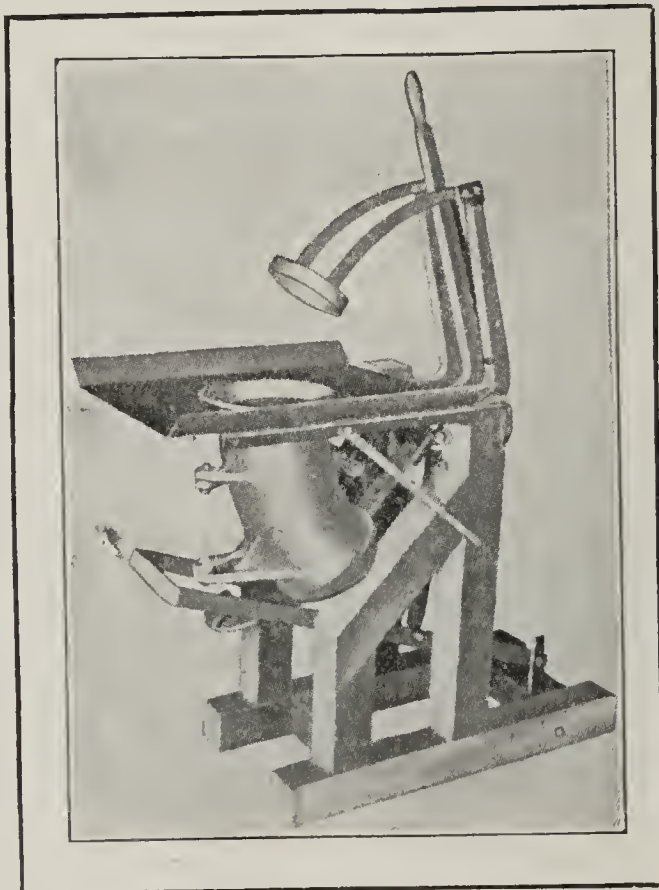
Ask for Catalogue or any information regarding our system.

Fisher Hydraulic Stone & Machinery Co.
MOUNT GILEAD, OHIO.

Concrete Sewer Pipe Bends

**The Only Machine
of Its Kind
on the Market.**

Concrete Sewer Pipe
Bends Made on the
**RICKMAN SEWER PIPE
BEND MACHINE** Make
Money for the Manu-
facturer.



**The Latest Thing
Added to the Concrete
Machinery Line.**

ONE MAN can make from 15 to 20 curved sections of pipe per hour. Shovel in the material, tamp it with the tamping ring, operated by foot lever, attach the bell-end form, complete the section, withdraw core from below, by lever, carry the pipe away to a pallet and bring the outer mold back to the machine.

You Need This Machine to Complete the Equipment of Your Tile Factory

Write for Circulars and Prices

R. L. RICKMAN CO.,

**987 Westminster Avenue,
VANCOUVER, B. C.**

"A COMPLETE SUCCESS" IN AUSTRALIA

International Process (Patented) "Division = Method"

POSTAL TELEGRAPH - COMMERCIAL CABLES
CLARENCE H. WACKAY, PRESIDENT
CABLEGRAM RECEIVED AT
20 BROAD ST., N. Y.

DELIVERY NO. *Dg*

The Postal Telegraph-Cable Company (Incorporated) transmits and delivers this cablegram subject to the terms and conditions printed on the back of this blank.

DESIGN PATENT APPLIED FOR

TO: *Mr. J. H. C. via 10/10*
MILWAUKEE, WIS., 24 1910
SUBJECT: *International Process (Patented) "Division = Method"*
TO BE DELIVERED TO: *Mr. J. H. C. via 10/10*

(Western Union Code)

A complete success. Present prospects indicate additional new works.

No inquiry respecting this message can be attended to without the production of this card. Repetitions of doubtful words should be obtained through the Company's offices and not by DIRECT application to the sender.

We received this cablegram from an Australian syndicate for whom we have just completed and set in operation two Single-Unit Silica Brick and Stone Factories.

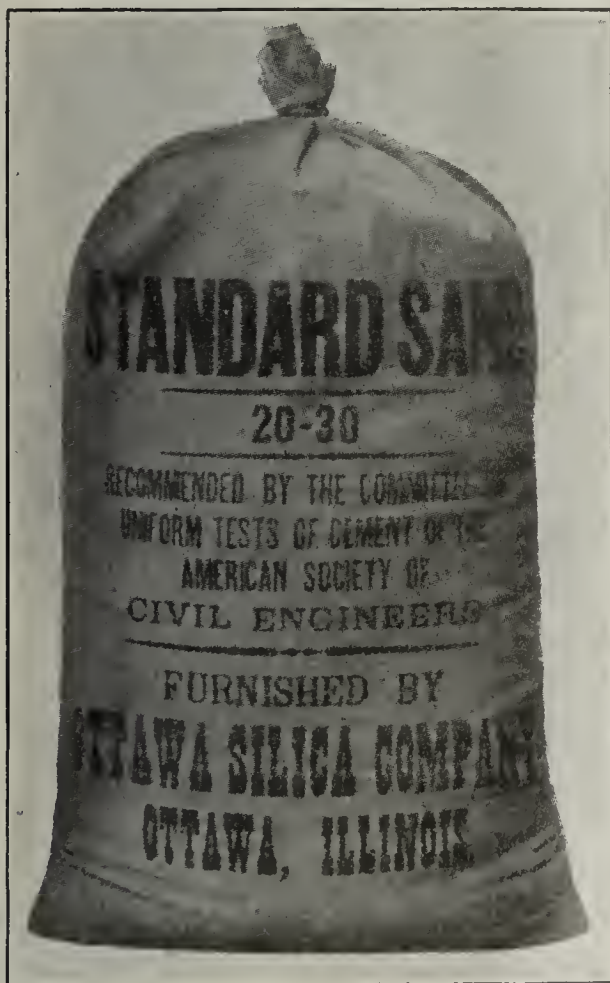
Our Factories are
ALWAYS A SUCCESS

Engineers and Contractors for
Silica Brick & Stone Factories

Write for Full Particulars.

International Sand-Lime Brick & Machinery Co., 90 WEST STREET
New York City

WASHED-STEAM DRIED and SCREENED **Ottawa White Sand**



Unexcelled for facing concrete blocks, ornamental concrete stone, etc.

Analysis 99.88

Prices, Freight Rates and Samples on Application.

You can order less than a carload, in fact shipments as small as five 175 lb. bags can be delivered economically.

SEE OUR EXHIBITS

New York Cement Show, Space No. 132. December 14-20, 1910
Chicago Cement Show, Space No. 11. February 17-23, 1911

DU PONT

OFFICES

BIRMINGHAM
BOSTON
BUFFALO
CHICAGO
CINCINNATI
DENVER
DULUTH
HAZLETON
HOUGHTON
HUNTINGTON
JOPLIN
KANSAS CITY
MEMPHIS
MEXICO CITY
NASHVILLE
NEW ORLEANS
NEW YORK
PHILADELPHIA
PITTSBURG, KAS.
PITTSBURGH, PA.
PORTLAND
SALT LAKE CITY
SAN FRANCISCO
SCRANTON
SEATTLE
SHREVEPORT
SPOKANE
SPRINGFIELD
ST. LOUIS
TERRE HAUTE

MONOBEL No. 1
is being used with great success in all kinds of ROCK BLASTING which is not very wet and where the material is not unusually hard. Does not require thawing.

EXPLOSIVES

1802
1910

E. I. DU PONT DE NEMOURS POWDER CO., Wilmington, Del., U.S.A.

COPYRIGHTED BY E. I. DU PONT DE NEMOURS POWDER COMPANY, 1910

SELECTED WHITE SAND

For.

Ornamental
Concrete
Stone



For.

Hard
Plaster
Finishing

Cement
Block

Facing

Exterior
Plastering

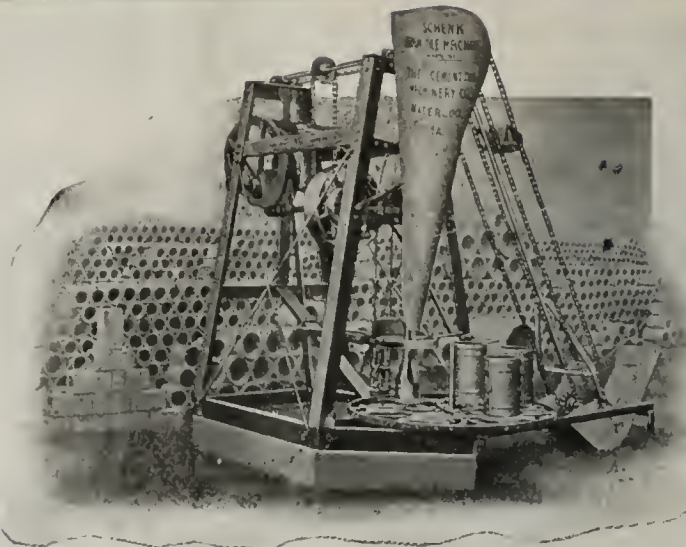
Stone & Marble Sawing

Shipped in paper lined box cars or 150 lb. bags

UNITED STATES SILICA CO.

1041 AMERICAN TRUST BLDG.

CHICAGO



The Schenk Cement Drain Tile Machine

is conceded by all who are familiar with the concrete machinery business to be absolutely the most perfect and the most successful machine in the field; upon its merits the cement drain tile industry has been built; and on account of its success other machines have been constructed, but no machine at the present date surpasses the Schenk Machine for capacity, durability, convenience, economical operation and for satisfaction.

We sell the Schenk on an Iron Clad Guarantee, backed by the largest exclusive concrete machinery manufacturers in the world.

Our free catalog, "Money in Cement Tile" will give you interesting information relative to the proper equipment, the construction of buildings the amount of capital required, the amount of profit to be expected; in fact, it tells how to start a plant for the manufacture of cement drain tile and just what you will be able to realize on your investment.

Write for it today.

The Cement Tile Machinery Co.
WATERLOO, IOWA

ALWAYS
ON HAND

THE AMERICAN CLAY MACHINERY CO.

Willoughby, Ohio, U.S.A.

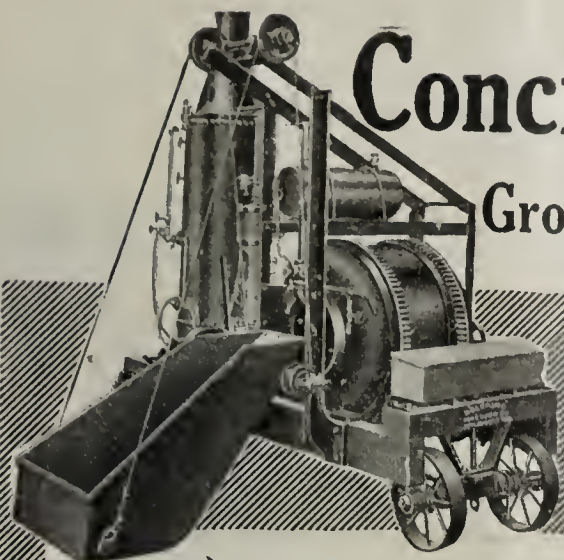
PLANTS
DESIGNED

COMPLETE EQUIPMENT
FURNISHED,
AND INSTALLED
SET IN OPERATION

SAND-LIME BRICK MACHINERY

Built Right
Run Right

GRIZ



Concrete Mixer Theories

Grow Into Definite Mixing Knowledge

When Every Mixing Action Is A
Known Positive Mechanical Force



There's An Individuality About Koehring Mixing—It's Known Mixing

The drum is a plain cylinder with heavy cast iron heads, but, bear in mind, it's made without *deflecting faces* or other *obstructions* to limit the *end-to-end* mixing.

The mixing blades are so arranged that they not only *lift and pour* the aggregates from the side but carry them alternately from *end-to-end* and *break them over* against the heavy heads.

There's no *guess-work* about it—no rolling over in the *center* of the drum—every action of the aggregates is performed by a *known, positive* mechanical force.

But there's another mixing than this in the Koehring Mixer.

—When not in discharge position, the inner end of the discharge chute is tilted downward.

—Material carried up by the mixing scoops at the side is discharged onto the inwardly and downwardly extending chute and descends from the inner end in a *continuous flow*, the entire width of the chute, and falls to the bottom at *right angles*, to that from the *mixing scoops* and the *end-to-end* mixing.

That's *three independent mixings*, every one of them a *known* mixing and no *theories* required to explain them.

Three known mixings in one, is why the *Koehring Mixer* is the *fastest in existence*.

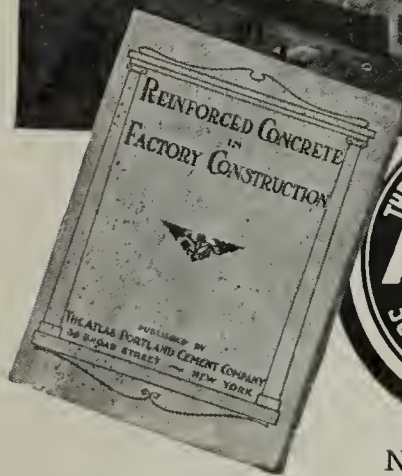
But known mixing is not its only improvements over old style batch mixers.

—The trunnion rollers are cast with *wide faces*, *chilled* to extreme hardness and placed wide apart at the extreme ends of the drum.

This not only guarantees a *stable equilibrium* to the drum but insures its maintaining *perfect alignment* even after years of service. The outer end of the discharge chute does not tilt downward, affording ample clearance for wheelbarrows, even in the *smallest sizes*.

There are other *worth considering* features, that every mechanical mind *knows* are correct in principle, explained in our new catalog. Do not fail to write for it at once, being sure to mention "Catalog B."

KOEHRING MACHINE CO., 614-616 GERMANIA BUILDING
MILWAUKEE, WIS., U. S. A.



None Just As Good

The book, "REINFORCED CONCRETE IN FACTORY CONSTRUCTION," will be sent for 10c. It illustrates and describes many different types of factories built of concrete. It demonstrates the economy, safety, convenience and adaptability of concrete for all factory purposes.

Other books in the Atlas Cement Library:

Concrete Houses and Cottages Vol. I. Large Houses \$1.00

Vol. II. Small Houses 1.00

Concrete Construction about the Home and on the Farm, Free

Concrete in Highway Construction 1.00

Concrete in Railroad Construction 1.00

Concrete Cottages, Free Concrete Garages, Free

If your dealer cannot supply you with Atlas, write to

THE ATLAS PORTLAND CEMENT COMPANY
DEPT. D. 30 BROAD STREET, N. Y.

Largest productive capacity of any cement company in the world. Over 50,000 barrels per day.

Hotel Cumberland

NEW YORK

S.W. Cor. Broadway and 54th St.

Near 50th Street Subway Station and 53d Street Elevated

HEADQUARTERS FOR THE CEMENT
AND MACHINERY MEN.

New

Modern

Fire Proof

All Outside Rooms. No Carpets. All Oriental Rugs.

Transient Rates \$2.50 with Bath and up.

10 minutes walk to 20 theatres.

Send for Booklet.

HARRY P. SIMPSON, Formerly with Hotel Imperial.

R. J. BINGHAM, Formerly with Hotel Woodward

CHARLES F. MCKENNA, Ph. D.

Inspection of Cement

and all other Engineering Materials. Examination of Properties and of Economical Operation of Works.

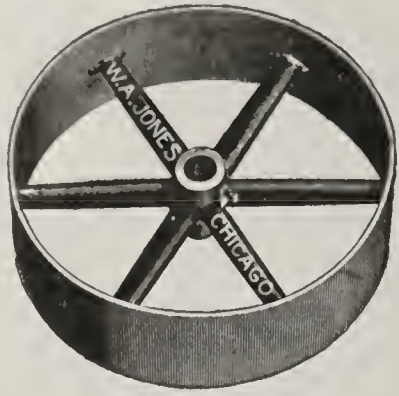
Consulting and General Practice in
Chemistry, Technology, Chemical
Engineering and Chemo-
Legal Cases.

Long Distance Telephone.

Cable Address: PLAT PEARL

Laboratories: 221 Pearl St., New York City

Offices: 50 Church Street



THE JONES Line of Transmission Machinery

Is Used by Progressive Manufacturers

ROPE SHEAVES, GEARS, FRICTION CLUTCHES,
SPROCKET WHEELS, SHAFTING, HANGERS

PULLEYS

A Complete Line of

POWER TRANSMITTING MACHINERY

W. A. Jones Foundry & Machine Company

NORTH AVENUE and NOBLE STREET, CHICAGO

The Best for All Uses

Uniform = Strong = Durable

EVERY BARRELL GUARANTEED

WM. G. HARTRANFT CEMENT CO.

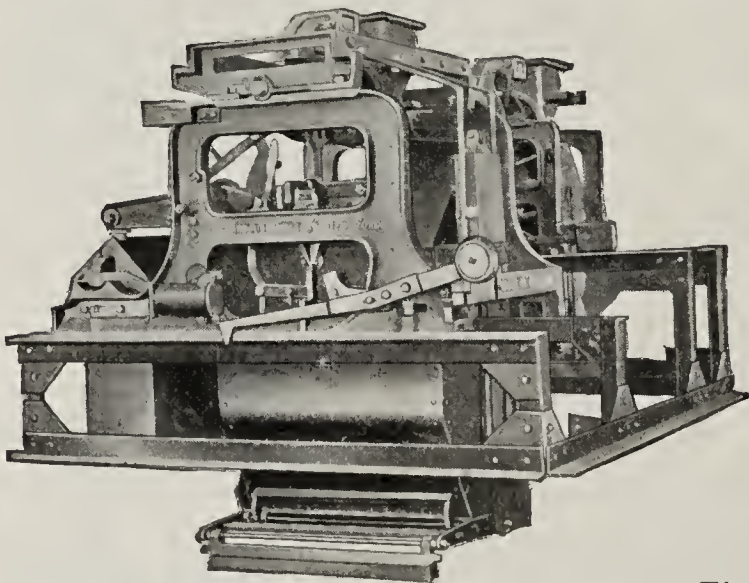
SOLE SELLING AGENT

Real Estate Trust Bldg,

PHILADELPHIA



TO MAKE THE BEST CEMENT, USE Richardson's Automatic Proportioning Scales



Two or more scales yoked together with our Electric Discharge Mechanism will weigh Crushed Raw Materials direct from bins with perfect accuracy and discharge simultaneously.

These machines fitted with our Conveyor Feed will also weigh Pulverized Materials direct from bins.

Greatest Possible Range of Weights. Exact Proportions Absolutely Guaranteed. Continuous Uninterrupted Operation.

Similar Machines for Clinker and Gypsum. Automatic Hopper Scales for weighing Cement to Stock Bins. Automatic Bagging Scales for Finished Cement. Speedy and most accurate yet devised.

Write for particulars to

RICHARDSON SCALE COMPANY
16 Park Row, NEW YORK 122 Monroe St., CHICAGO

Ball Mould \$2.55

Attractive Draws Easily Sells Readily

Ornamental Moulds Bring Good Profits
at any Time of the Year



WHOLESALE CATALOG.

Send for Big Wholesale Catalog. It is an encyclopedia of what you ought to have and at prices you ought to pay.

Send for it today. It lists everything.

Northwestern Steel & Iron Works

EAU CLAIRE, WIS.

BOX 844

CEMENT

... AND ...

ENGINEERING NEWS



A reinforced concrete water tower, 110 feet in height, constructed for the Cananaa Yaqui River & Pacific Railway Company, at Empalme, near Guaymas, Mexico. Carl Leonhardt, Los Angeles, Cal., Contractor.

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

WILLIAM SEAFERT, Editor and Publisher

OFIFCE—22 Fifth Avenue

Cable Address -- "Seaferta" Chicago.

Entered at the Post Office at Chicago, as Second-class matter, July 21, 1896
under Act of March 3d, 1879.

Subscription. \$2.00 Per Year
Foreign Subscription. \$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON

Advertising Manager

Chicago, October 1910.

DISPUTABLE PATENTS.

Most people who have ever had any dealings with the U. S. Patent Office know from experience how readily patents are granted in this country and how little protection they afford.

Leaving entirely out of consideration the many applications which, according to a statement of the Department of the Interior, the Patent Office receives daily on all kinds of devices in common use and known to every one, but which nevertheless are claimed to be new and useful improvements, a great number of applications remain, belonging to all trades, upon which only men conversant with the special branches of technology can pass judgment. The patent examiner, therefore, generally calls for advice upon men of the profession who are supposed to be experts in their line of business. However, even these are liable to make mistakes or can not possibly be expected to be posted on everything going on in their trade. Thus, it happens that patents are granted on mechanical devices or processes of manufacture or methods of working which are not new by any means, but which are merely presented to the Patent Office under a different garb or explained in a manner more up-to-date, so that the Patent Examiner believes to have the description of an entirely novel process before him.

The applicant frequently has no other means of ascertaining, whether or not his invention is patentable, than consulting the files of the letters-patent issued on similar subjects. If his invention is not covered by any of the patents published, he can almost be sure that his claim will be accepted. In most instances there will be no objection on the part of the profession, as, in all cases in which mechanical devices are described, it will be comparatively easy to prove by the accompanying drawings or sketches, whether or not the application contains an improvement or something radically new. Yet, if the application describes a process of manufacture or a method of operation, which are claimed to be different from the prevailing practice or to be improvements over existing patents, it frequently happens that the inventor is informed by the profession, that his patented process has been in common use for years prior to his application, or that he finds out in time that his invention is used by the public. In this event, he will mostly draw the conclusion that his patent rights are being infringed and, only in a few cases, will it occur to him that his patented process was known to the World before he ever thought of it, but that the original inventor did not believe the process to be of sufficient importance to have it patented or would not spend time and money on it, reasoning that only people of large means are able to defend their patent rights and that it would be impossible for him to find out who makes use of his invention.

The cement industry seems to be singularly prolific in cases of the latter class. Almost every report from the Patent Office contains inventions describing processes of manufacturing cement or methods of waterproofing concrete which are known to the initiated from daily observation or can even be found to be described in the domestic or foreign literature on the subject. To cite a few of the latest happenings that have come to our knowledge, we may mention the repeated efforts that are made to have the Patent Office grant letters-patent on fluxes to be added to Portland cement with a view to lowering the burning temperature. This subject has become of paramount importance since the beginning of the manufacture of White Portland cement. Prior to that time, probably only few American Portland cement manufacturers knew that, in foreign countries where upright kilns were used and where frequently not the same high burning temperature could be maintained as in rotary kilns, an admixture of fluxes to cement raw materials was a daily occurrence. Calcium fluoride, alkalies and cryolite were in common use in the manufacture of ordinary Portland cement and can, therefore, be used for calcining white Portland cement just as well today without infringing upon patents issued by the U. S. patent examiners who were unfamiliar with the subject.

In the same way as the practice of admixing finely powdered sand to Portland cement, or rather the re-grinding of the latter with sand, ceased to be a patented process when it was proven that several structures in the East had been erected with a similar sand-cement mixture previous to the application for a patent, thus all present and future patents will be declared to be void, whenever it can be testified that the process, forming the subject of the patent, was used prior to the application.

A third process, recently patented, namely the mixing of colloidal cement (Portland cement transformed into a jelly by large amounts of water) with concrete for the sake of waterproofing it, caused much disappointment to the owner of the patent upon being told that in Chicago, about six years ago, a number of houses were built with concrete blocks waterproofed in substantially the same way as described in his patent. Mr. Krottnaurer who first used this process did not think of having it patented, as it would have been impossible for him to prevent any one from using it without closely watching every concrete building going up in the country.

Krottnaurer, the instructor of all practical cement men in the East and Middle West, who taught the various managers of cement plants how to burn Portland cement during the period of development of the rotary kiln process, did likewise not apply for a patent when he re-ground Portland cement with sand, nor did he try to obtain patents on adding fluxes to Portland cement raw mixtures. He brought this experience with him from Europe and made freely use of it in this country, and others went and secured patents on what they saw him do. He proved that he ground sand with Portland cement that went into several public buildings at Philadelphia and thus annulled the Silica-Portland cement patents, and, if need be, will prove that he used, in the manufacture on a large scale, all the available fluxes for reducing the burning temperature of Portland cement and that he erected houses of concrete blocks waterproofed with cement jelly.

A preliminary study of the chances that a would-be inventor has in succeeding with his patent must not be confined to an examination of the files at the Patent Office, but requires at the same time a thorough knowledge of what is going on in the cement world. The old practice of securing patents on processes that are in common use in other countries, which will be continued until the U. S.

Patent Office will be sufficiently posted on foreign matters, proves to be expensive and troublesome to the patentee and generally ends with the final annulment of the patent.

THE CALCIUM SILICATES AND CALCIUM ALUMINATES CONTAINED IN PORTLAND CEMENT.

By Dr. O. Schott.

Translated by Dr. W. Michaelis, Jr.

(Continued from page 377)

DESCRIPTION OF EXPERIMENTS:

Raw Materials: The experimental part of my work began with the preparation of chemically pure raw materials. Especially the calcium silicates required materials of absolute purity, as even small amounts of adulterations caused the fused products to assume entirely different properties.

As raw materials I used calcium carbonate, calcium oxide, calcium sulphate, silicium oxide (silica), aluminum oxide (alumina) and iron oxide, which I prepared in the following way:

Calcium Sulphate: Calcium chloride was dissolved in water, containing a small amount of hydrochloric acid, and boiled with hydrated lime. The filtrate was heated and precipitated with diluted sulphuric acid. The precipitated calcium sulphate was washed out in large vessels for a long time until only a trace of chlorine was left. Then it was collected on a filter, washed out several times with boiling water and dried, and finally burnt in a furnace at 1200 centigrade in a covered porcelain dish. The de-hydrated product represented a fine white powder.

Calcium Carbonate and Calcium Oxide: Calcium chloride was dissolved again in water, which contained some hydrochloric acid, and the small amount of iron and alumina in it was precipitated with hydrated lime. To the filtrate ammonium carbonate was added and thus calcium carbonate precipitated, which had to be washed until it was free of chlorine. The precipitate was collected on a filter, washed with boiling water and ultimately dried in a drying oven at 110 centigrade. Calcium oxide was obtained by burning of the carbonate in a muffle furnace at 1200 centigrade. In the state of red heat, it was transferred into a glass vessel with well-fitting stopper.

Silica: Several attempts were made to obtain, by precipitation with hydrochloric acid, pure silica from a water glass solution which contained 25.7% of iron oxide.

For this purpose, the water glass solution was strongly diluted and precipitated with diluted hydrochloric acid. The thoroughly washed gelatinous silica was then filtered and dried on a water bath. The product represented a granular mass which could be ground only with difficulty. It was not suitable in this state, because thorough mixing of the raw materials required all substances to be in a fine state of subdivision. Even if the filtrate was pressed through a linen cloth, it dried in granular form. For this reason, the drying of the silica was abandoned and the wet filtrate preserved in glass jars. Thus wet gelatinous silica was used in the preparation of the mixtures after the amount of water had been previously determined in it.

In addition to the former method, silica was prepared from calcium fluoride, quartz and sulphuric

acid: In a lead-damagan (demijohn) a mixture of 1 part calcium fluoride and 2 parts of powdered quartz sand was treated with concentrated sulphuric acid and the escaping silicium fluoride gas was passed into a large vessel filled with water, in which the silica was precipitated. The silicium hydro-fluoric acid forming at the same time was washed out, and the silica collected on a filter and washed again with boiling water. The water was then removed from the wet silica by washing with alcohol and the silica was ultimately dried on a water bath. The final product represented a very voluminous light white powder, weighing as little as 50 grams per liter. Efforts to recover the silica from the silicium hydro-fluoric acid contained in the filtrate by means of ammonia were futile, as it proved to be granular upon drying.

An attempt to obtain silica from Portland cement by decomposing it with hydrochloric acid proved to be a very laborious task. Besides, invariably a gray impure silica resulted from it.



No. 6.

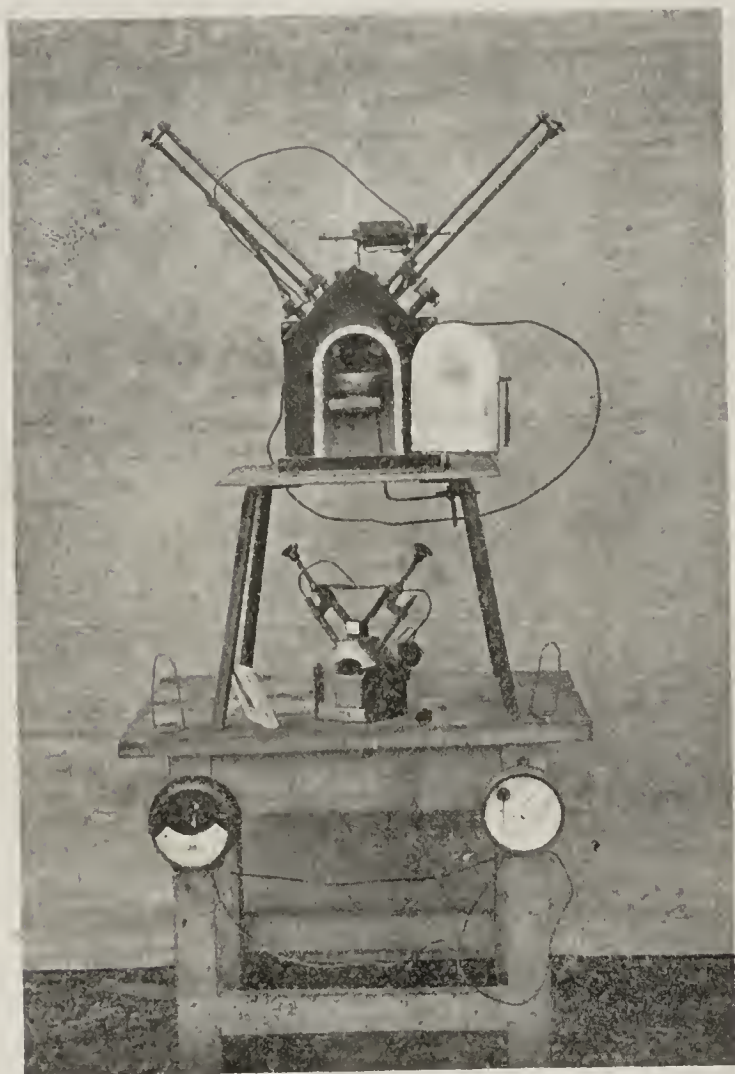
Furthermore, I tried to dissolve silica in water under a pressure of 10 atmospheres in an autoclave. This was connected with considerable difficulty. If a glass beaker was used, sodium and potassium from the glass substance were found in the solution. Besides, the water condensing on the metal cover of the autoclave and dripping into the water further spoiled the solution. Therefore, the open glass beaker was replaced by a porcelain beaker with porcelain cover. One liter of water was stirred with 10 grams of dry silica and placed into the autoclave, but even after heating for 12 hours at a pressure of 10 atmospheres only 0.1% of silica were dissolved. However, upon using freshly precipitated moist silica, a 1% solution was obtained under favorable conditions; but usually it contained only 0.8% or 0.9% of silica. The solution was opalescent and had a peculiar odor. In time, some of the silica in solution precipitated.

Iron Oxide: Iron chloride was dissolved in water and filtered. To the hot solution ammonia was added. The very voluminous precipitate was washed out for 4 days then filtered and washed on the filter with hot water. After this it was dried on a water bath and heated at 150 centigrade in a drying oven.

Alumina: Metallic aluminum was dissolved in hydrochloric acid and the alumina precipitated with ammonia water. The gelatinous white precipitate was washed for several days, filtered and washed again with hot water.

After having been dried on a water bath it was heated, at 150 centigrade, until it was absolutely free from water, and preserved in tight glass jars. All these self-prepared chemicals, which proved to be chemically pure according to the analyses made, were used only for the experiments on a small scale. For the experiments on a large scale, Merck's chemicals were used after having been analyzed carefully. These chemicals were rather pure. In order to show the degree of their purity, I herewith state their composition:

Calcium Sulphate: Loss at red heat 21.1%. Alumina plus iron oxide 0.2%. The granular white powder was ground in a porcelain mortar until all of it passed a 200 mesh sieve.



No. 7

Iron Oxide: Loss at red heat 0.25%. Free from other elements.

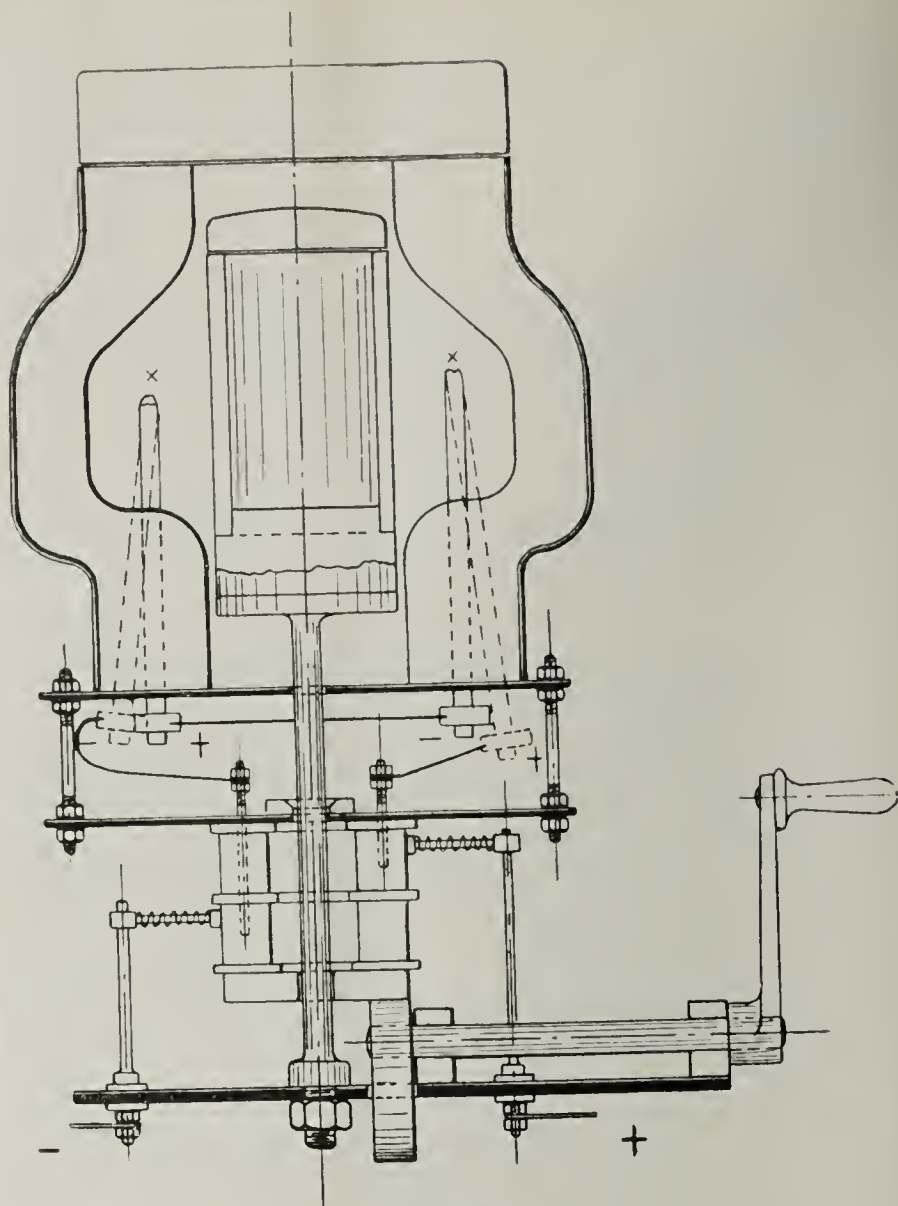
Alumina: Loss at red heat 44%. Free from foreign substances. Granular powder which had to be ground in a porcelain mortar.

Silica: Granular powder. Only that part of the commercial product was used which passed a 200 mesh sieve. Loss at red heat 13.9%. Iron oxide 0.15%.

Water Glass Solution: Silica 26.75%. Alumina plus iron oxide 0.25%. Sodium 7.30%.

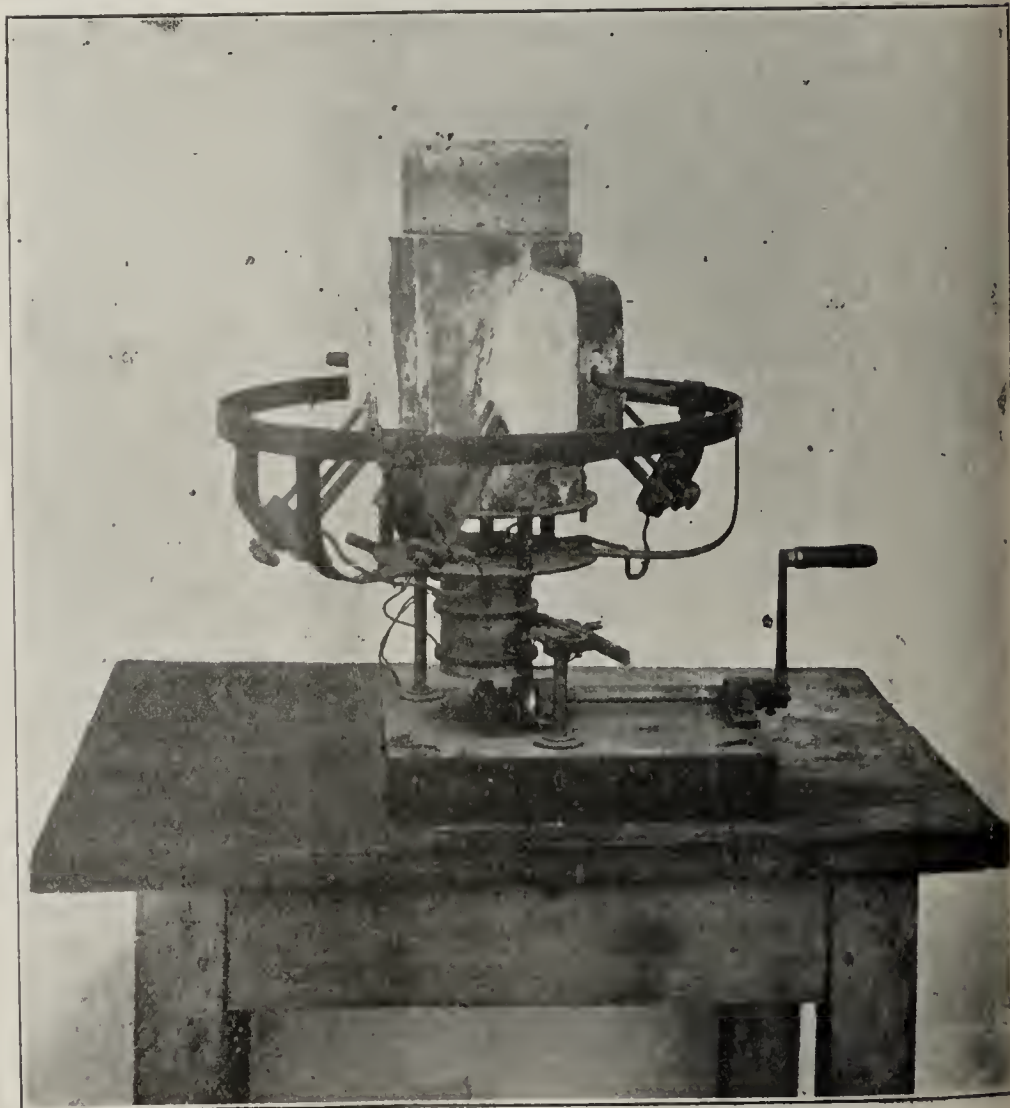
Calcium Chloride: As the commercial calcium chloride was adulterated with iron oxide, it was dissolved and iron precipitated with hydrated lime. Upon filtering, the solution proved to be chemically pure. The concentration of the various solutions were between 16% to 20%.

In the course of my experiments I kept Jordis and Kanter's advice in mind to start with the simplest compounds and to work up systematically to more



No. 8.

complicated compound and to examine their behavior towards water, carbonic acid and other reagents without allowing experiments made by others to influence my work. As far as possible, I determined the burning temperatures and observed the difference between slowly and quickly cooled compounds. Spe-



No. 9.

cial attention was given to the determination of the causes of disintegration and, for this reason, some experiments had to be repeated a hundred times. With the same care I examined the setting and hardening properties of my products as well as the phenomena of blowing accompanying some of them. Unfortunately, however, there was no time left for a microscopical examination of the fused mixtures. After having discovered, in the course of a superficial examination of eighty microscopic sections of the various Portland cements from different countries, that their crystalline structure varied according to the method of burning (vertical kiln, Hoffmann-kiln, rotary kiln, electric furnace) and that the structure of the same clinker changed at higher temperatures, I considered it useless to make an attempt at identifying the preparations obtained by synthesis with minerals to be found in the cement clinker, especially because some of them, as for instance di-calcium silicate and "tri-calcium silicate", could be obtained only by fusion in an electric furnace. A similar investigation would require a special study occupying a great deal of time, as the generalization of the facts observed would necessitate the burning of a great number of cements at varying temperatures and the preparation of hundreds of microscopic sections.

Thus I made use of the microscope only in cases in which it was doubtful, whether or not uniform fused products had been obtained, after all efforts to prove this in some other way had failed.

Furnaces Used for Obtaining High Temperatures:

In preparing by synthesis the calcium silicates and calcium aluminates which may possibly be present in Portland cement, I endeavored to copy as much as possible the conditions existing in the manufacture of Portland cement.

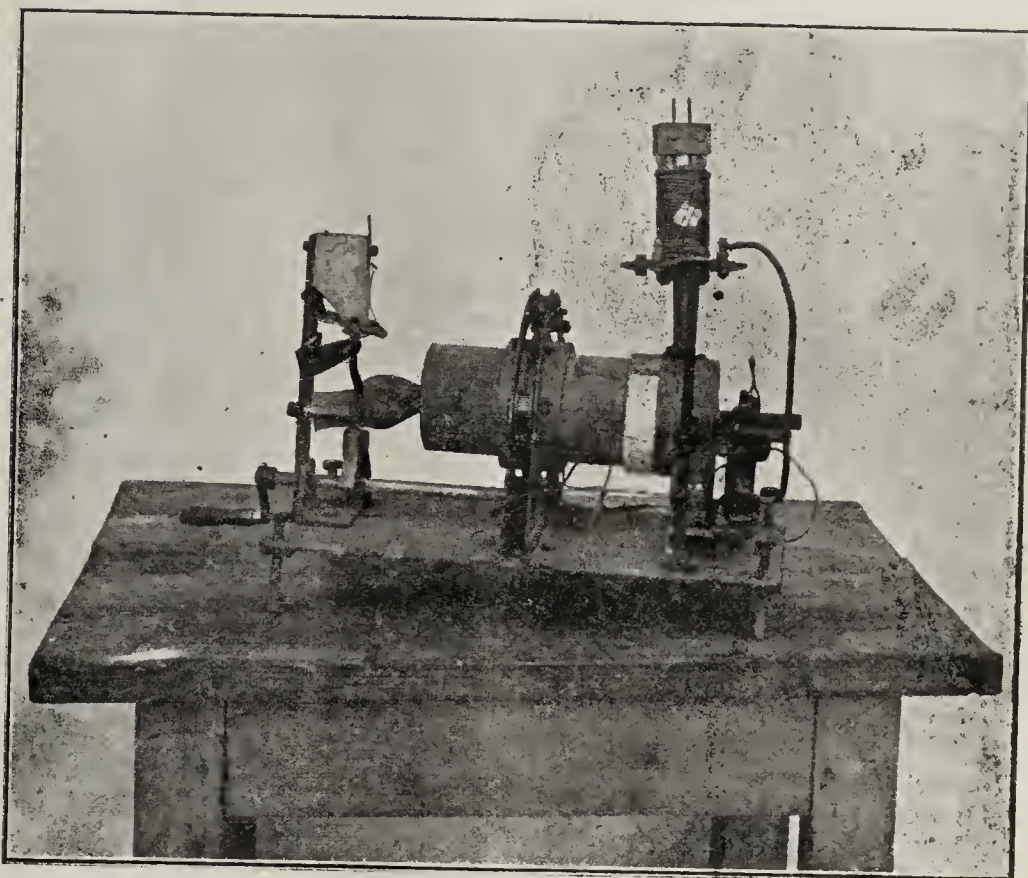
However, the preparation of pure products for scientific purposes made the customary use of coal or coke for the burning prohibitive, as otherwise the melting compounds would have been adulterated with the ashes of the fuel. Thus, only two methods remained, namely heating with gas or by electricity. I used furnaces of both systems and obtained the best results with electric furnaces, which I had to construct especially for this purpose.

As mechanical devices for the obtaining of high temperatures will become a necessity more and more in chemical technology, I believe a detailed description of my furnaces and my experience with them will be welcomed by many readers of this publication. As I did not anticipate that the basic calcium silicates required as high a temperature as was found out later, I used a so-called Heinecke furnace in the beginning. This furnace is heated by six gas burners set in a circle. The air is pre-heated automatically. A 1½ inch gas pipe supplies the necessary volume of gas. The material is placed in a crucible of a very refractory clay. The maximum temperature which could be obtained by this furnace, after firing for 3 hours, was 1450 centigrade, measured with a Le Chatelier pyrometer; hence a temperature at which Portland cement can just be burnt.

Then I built a small rotary kiln, copying an experimental furnace used at Ann Arbor, Michigan. This was a model of the rotary kilns customary in practice, however, it was not heated with powdered coal but with gas. Yet, with this furnace I could not exceed a temperature of 1400 centigrade, which did not

even suffice for the burning of the Heidelberg Portland cement raw mixture.

A further experiment was made with a coke oven connected with a blower. With this I was able to obtain very high temperatures. However, all attempts at burning calcium silicates failed; they were adulterated either with the coke or with the crucible substance. All refractory vessels fused in it and the temperature could be regulated only with great difficulty. I used fire-clay crucibles and tubes containing a small admixture of kaolin, which withstood a temperature of 1800 centigrade and worked very well up to 1700 centigrade. Recently, a preparation called "diamantine" has been put on the market which consists of fused alumina containing a small percentage of silica and which successfully withstands even 1900 centigrades. Also this material was frequently used for crucibles and tubes. In order to be able to mould it, an admixture of 10% of kaolin was required. The melting point was lowered thereby, so that crucibles made of it could likewise be used only up to 1700 centigrade.

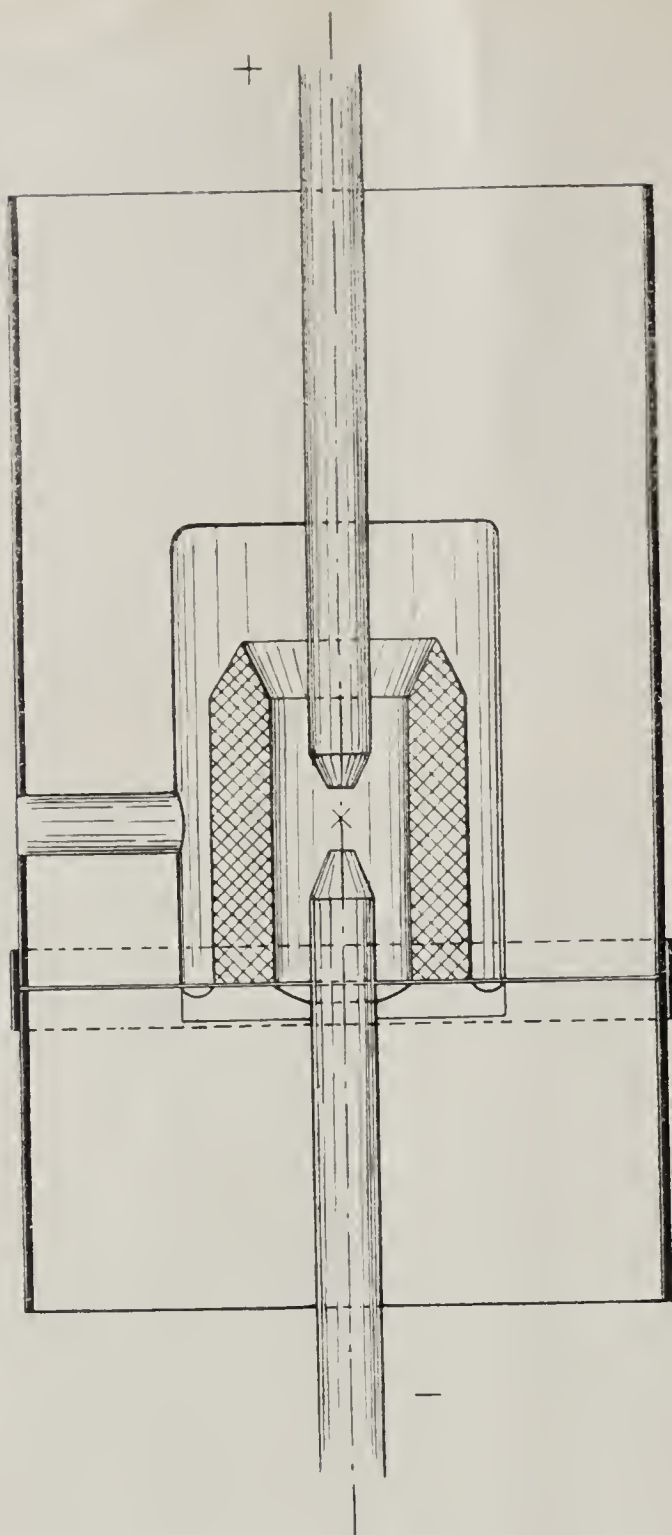


No. 10.

In order to prevent coke particles from coming in contact with the fusing product and in order to make the best use of the fuel, I placed a refractory tube, 20 in. long and 3 in. in diam., in the center of the blast furnace. This tube was perforated all over with half-inch holes about an inch apart. The furnace was covered in such a way that the flames had to go through the holes into the interior of the tube, in which a massive cylinder of the mixture to be burnt was suspended from a platinum wire. However, I did not succeed in vitrifying a di-calcium silicate mixture by this device, as the fire-clay tube as well as the platinum wire fused before the cylinder began to sinter.

The tubular furnaces of Heraeus with platinum foil as resistance answered my purpose up to temperatures of 1500 centigrade. I used two such furnaces; one of them was about 2 in. in diam. and the other 1 in. in diam. In the latter I could burn all aluminates.

I hoped to be able to avoid the adhering of the fused products to the walls of the platinum vessels by making use of a platinum crucible with bottom



No. 11.

valve which would let the thin fused liquid flow out. But, in the first place, the temperature was not high enough to render the fused masses sufficiently liquid, and, in the second place, the liquid mass, dropping out of the crucible, frequently came in contact with the walls of the tubular furnace, so that a hole was burnt in it after a short time, even if the furnace was placed perfectly vertical.

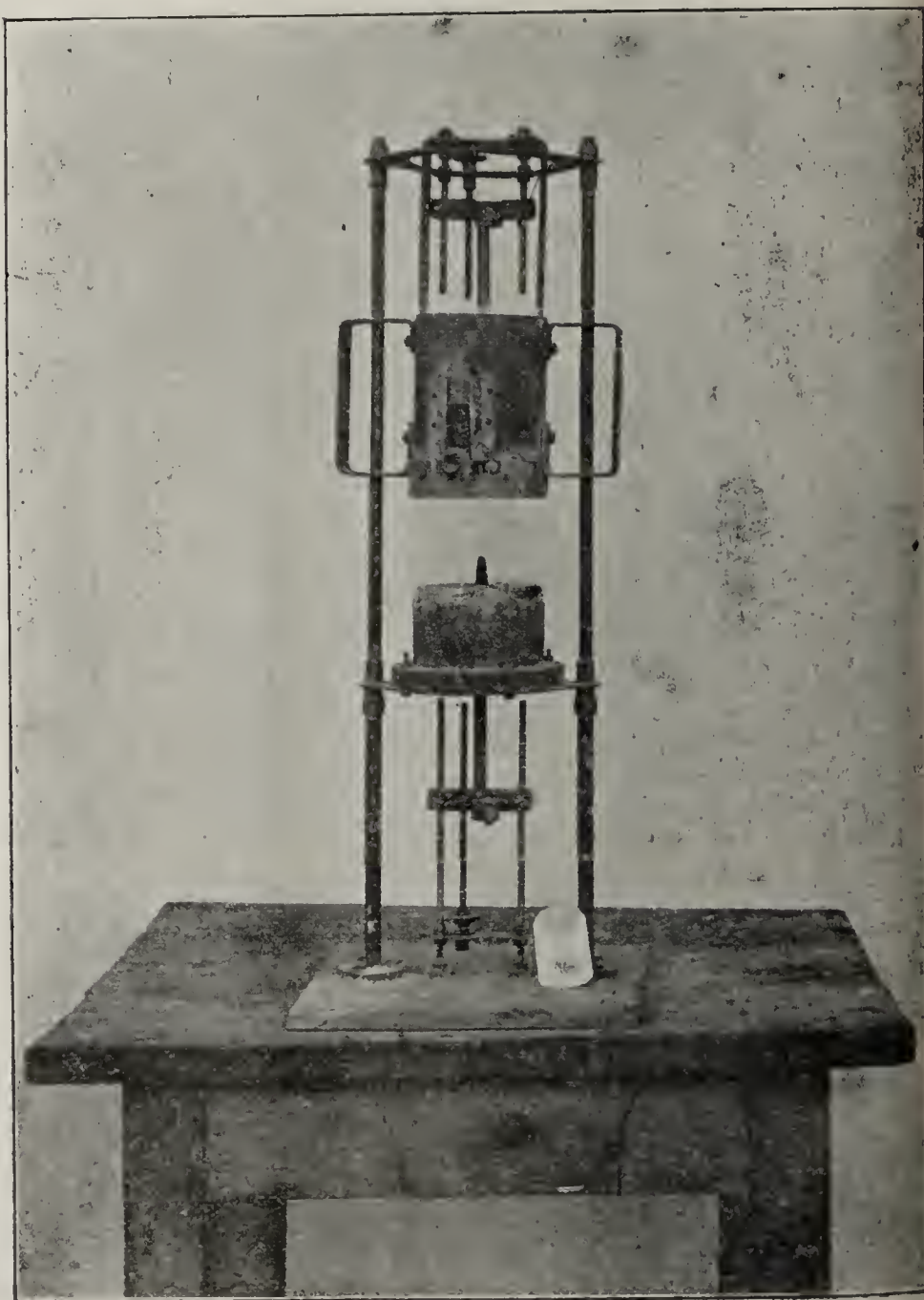
To overcome this difficulty I used a platinum frame, as illustrated by cut No. 6, in which I suspended the mixture in cylinder form inside of the tubular furnace. In this manner I obtained all mixtures sintering below 1500 centigrade as perfectly pure vitrified masses. The platinum frame could be opened and, therefore, permitted an easy removal of the clinkered mass.

The electric furnace, which I copied from Unger, resembled that of Moissan. A horizontal arc-light heated by radiation the material within a short distance from it. I could use this furnace with success for experiments on a small scale, but could obtain pure fused products only by introducing the mixture into the furnace over the arc-light. For this purpose, the mixture was rolled into bars 4 in. long and $\frac{1}{4}$ in. thick; these were placed in a porcelain tube. The front end of the bar was exposed to the heat of the arc-light until it fused and dropped out of the porcelain tube into the receptacle. This kind of furnace was built also on a larger scale for from 150 to 200

amp. at 135 volt. The carbon electrodes were placed at an angle of about 90 degrees, as cut No. 7 shows. The substance to be fused was enclosed in a dish of fused magnesia, which, by means of a worm gear, could be moved towards the arc-light or away from it according to the fusibility of the substance. In order to obviate adulteration of the fusing mass with carbon particles as much as possible, a rotary electromagnet was attached over the arc-light, which, according to its position, diverted the arc-light in a different direction and blew the carbon particles away. But, also this furnace did not yield very satisfactory results as far as the purity of the products was concerned. Especially in the case of mixtures higher in lime than the di-calcium silicate, calcium carbide was formed invariably, which was sometimes of a beautiful crystalline structure. If the latter was observed, disintegration of the fused mixture did not take place, whereas it happened regularly in the case of pure preparations.

Another electric furnace, represented by cuts 8 and 9, consisted of a diamantine tube heated by two arc-lights which rotated and moved up and down at the same time. This device could be used with great success for all products of a melting point below 1600 centigrade. The furnace was composed of an outer rotating mantle of refractory material, to the opposite sides of which two carbon electrodes were attached. By means of a gear and an eccentric the arc-lights were kept in rotation and, at the same time, were moved up and down continuously.

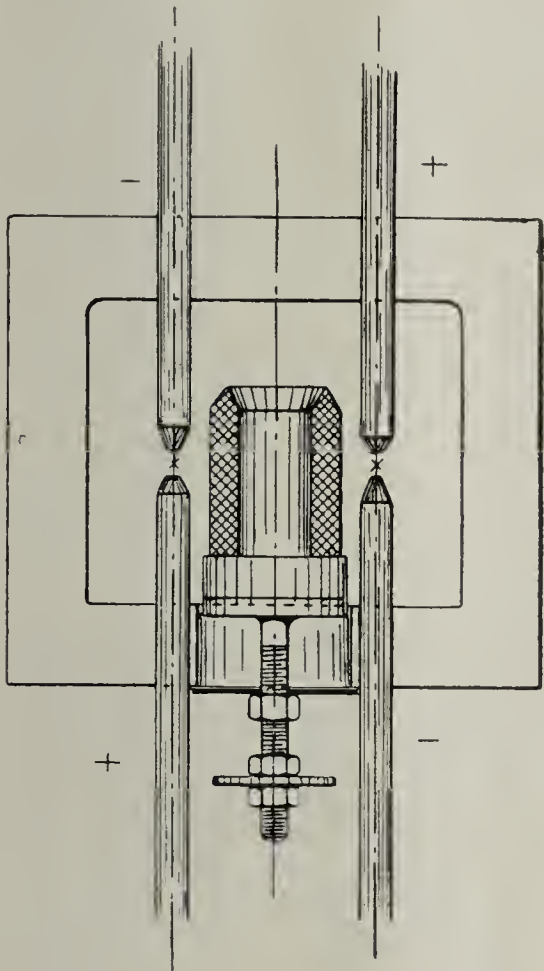
Enclosed within the rotating mantle and attached



No. 12.

to a firm base was a tube of diamantine 3 in. wide and 6 in. long which was permanently surrounded by the rotating electric arc. The maximum of temperature obtainable depended upon the resistance of the tube. It was impossible to let the rotating arc-lights act directly upon the fusing mass, because calcium carbide or aluminum carbide would have been formed by the carbon particles of the electrodes.

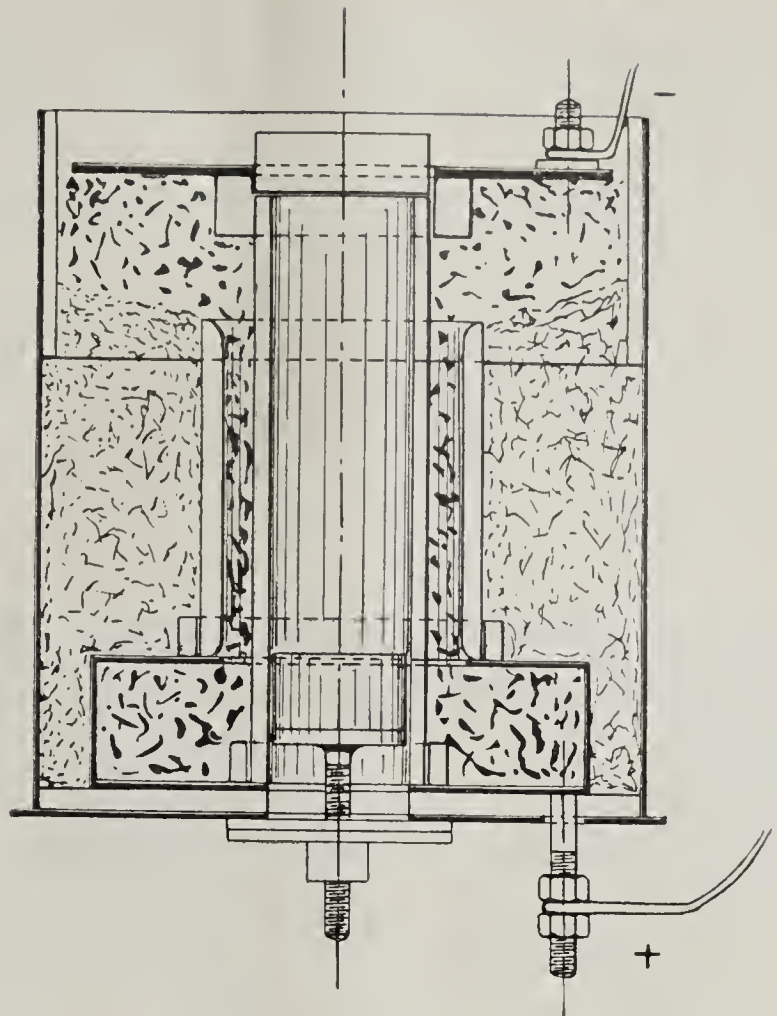
The various mixtures were placed, in the form of massive cylinders, 5 in. high and 2 in. in diam., upon a base of magnesite and sintered to the core, with the exception of the basic calcium silicates, which latter required higher temperatures. The volume of the cylinders after burning was usually one fourth of that of the original cylinder. (see cut No. 16.)



No. 13.

A small rotary furnace heated by electricity (represented by cut No. 10) was intended to clinker or fuse the material by the direct heat of the arc-light without spoiling the fusing mixtures by the carbon of the electrodes. The furnace consisted of two refractory tubes, one inside of the other. The interior longer pipe was slightly inclined and could be rotated. The material was moulded into small balls and introduced at the upper end of this revolving pipe. The other short stationary pipe, forming a jacket around the lower part of the rotary furnace, contained two carbon electrodes inclined at an acute angle. The arc-light was directed towards the front part of the furnace by means of a small electro-magnet in order to concentrate the heat upon the lower end of the furnace. At the place, where the rotating tube ended, the jacket had a hole through which the vitrified material was discharged. During the burning the wall of the furnace became coated with material fusing to it; this prevented further adulteration of the burnt product.

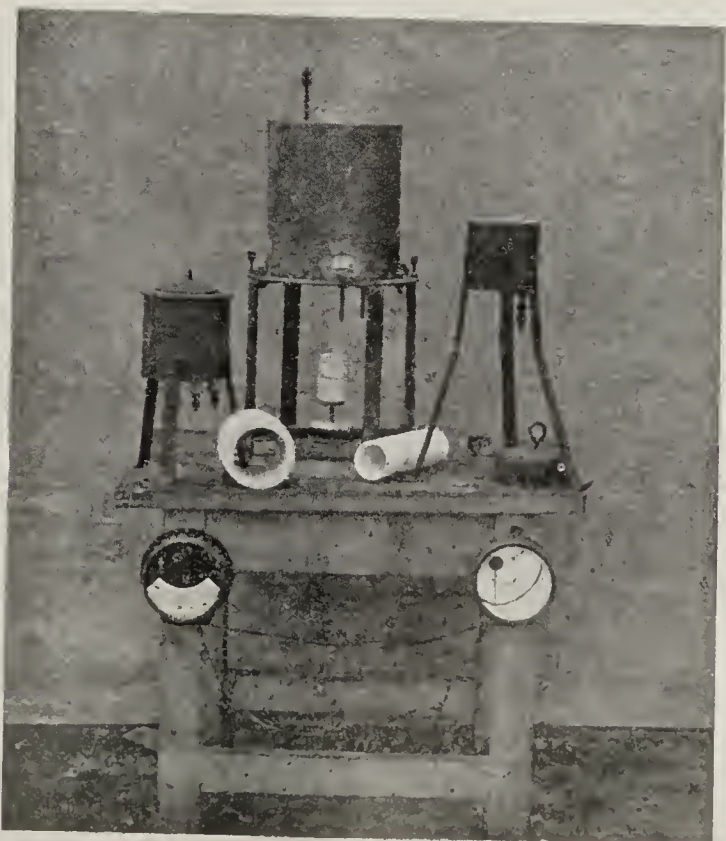
In spite of these precautions also this furnace did not give entirely satisfactory results, as contamination of the fusing substance by carbon particles could not be avoided. Especially the aluminates attracted the carbon with the greatest energy and formed a



No. 14.

black mass with it. The position of the carbon electrodes was frequently changed and yet, adulteration with carbon could not be prevented, so that it appeared out of the question to obtain pure fused products by direct contact with the arc-light.

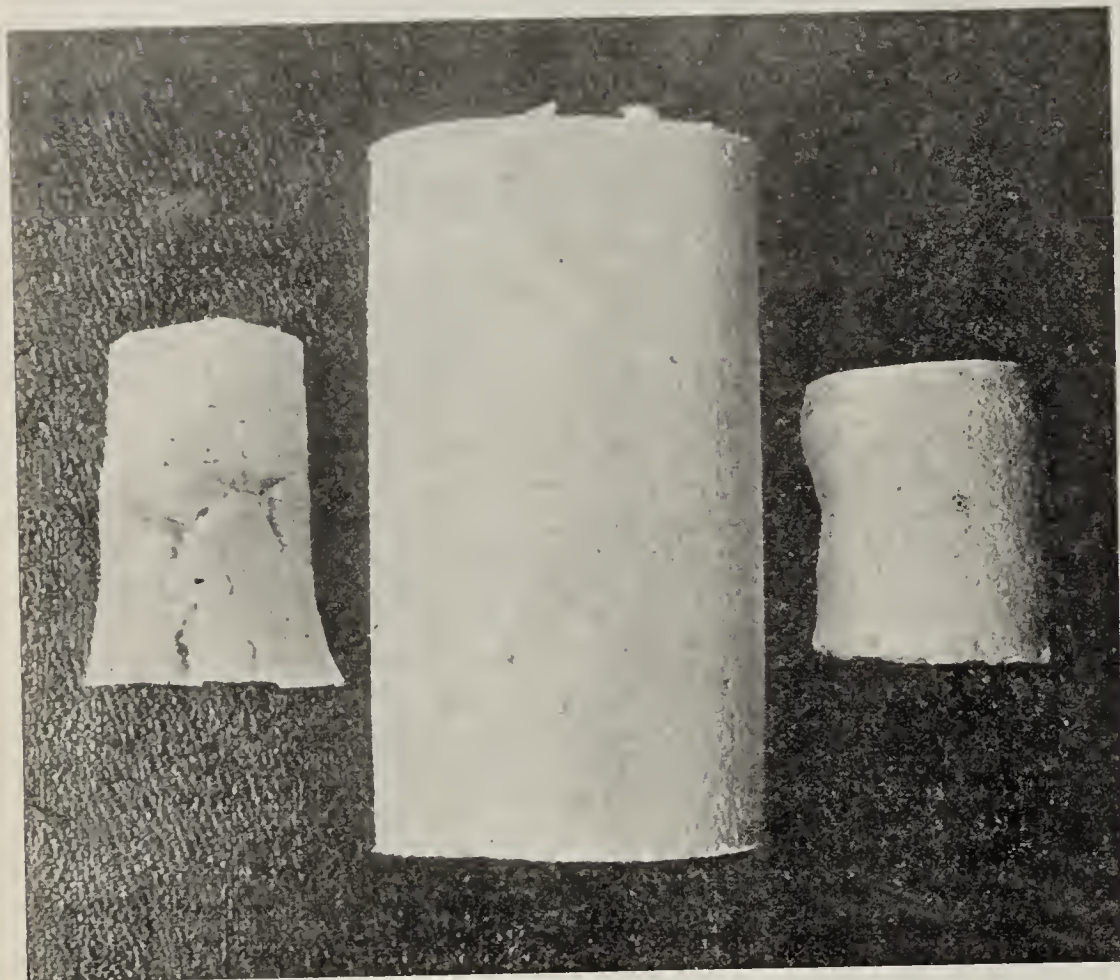
In the course of these experiments I made the observation that vertically placed carbon electrodes discharged the carbon particles invariably downward. This induced me to try to burn the mixtures in the form of hollow cylinders by the radiating heat of a vertical arc-light placed inside of the cylinders. Furthermore, I noticed that the wear of the carbon electrodes was a minimum if, after the furnace had reached a sufficiently high temperature, the air was excluded as much as possible by closing all openings



No. 15.

tightly. Then the carbons had not to be moved together from time to time and the amount of carbon particles discharged between the electrodes became very small.

The furnace built on this principle (see cuts No. 11 and 12) consisted of two vertical pipes, the upper of which could be raised; this contained the positive electrode which could be regulated. The negative electrode was enclosed in the lower pipe in such a way that both electrodes were in close contact when the upper part was lowered and the furnace was closed. The hollow cylinders, which had an outside diameter of three inches, and an inside diameter of two inches, hence walls one-half inch thick.



No. 16. Cylinders composed of calcium oxide and alumina. Before and after burning.

were pointed at the upper edges so that carbon particles could not settle on them. These cylinders were formed in a special brass mould from the moistened raw mixtures. The bottom of the furnace was lined with fused magnesia in which a 2-inch cavity was provided to take up carbon particles which might possibly fall down and thus to prevent adulteration of the fused cylinders. The inside of the furnace had to be as small as could be in order to obtain the highest possible heat. Where the upper and lower pipes came together, an asbestos ring was laid around the furnace to prevent loss of heat. Through a mica window in the wall of the furnace the progress of the burning could be observed. The length of the arc-light was regulated by moving the positive electrode by hand; the negative carbon had to be about 2 inches above the bottom of the furnace in order to give best results. With this furnace I could sinter and even fuse the most refractory mixtures. All that was required was to ascertain for each the necessary current, voltage and time of burning and to keep these data uniform for the same mixture. By this device I succeeded even in fusing the inner surface of a hollow cylinder of pure calcium oxide.

A similar furnace is represented by cut No. 13. The only difference between this and the former furnace was, that two arc-lights heated the outside of the hollow cylinders. The bottom on which the cylinder rested could be turned and was revolved at regular intervals. This furnace was used in combination with the former (cut No. 11 and 12), that is to say the cylinders which were burnt at first in the latter furnace on the outside were placed still red hot into the previously heated first described furnace (No. 11 and 12) in order to be heated from the inside. The burning with two pairs of electrodes, however, did not prove as economical as with one pair inside of the hollow cylinder, because the inside space of the furnace had to be much larger, which caused considerable waste of heat. Besides, in the latter style of furnace the arc-lights came in immediate contact with the lining of the furnace, so that also this was frequently affected by the heat.

Instead of furnace No. 8 and 9, with which I was able to obtain temperatures up to 1600 centigrade and thus could melt the aluminates, ferrites, monocalcium silicate as well as all double compounds, I used the furnace illustrated on cuts 14 and 15, as this was easier to handle, because the moving of the electrodes and the rotating became unnecessary.

The height of the temperature obtainable was, in this case, also dependent upon the refractoriness of the tubes used in connection with it, which were made of diamantine. This was a resistance-furnace using ground carbon of various size, for instance debris of the carbons of arc-lights.

The surface of contact between the metal and the ground coal had to be very large, while the layer of coal surrounding the heating chamber was only half an inch thick. A three-phase current of 50 amp. at 135 volt sufficed to obtain the necessary temperatures between 1400 and 1530 centigrade. The pressure exerted by the one-inch iron plate kept the mass of ground carbon tightly packed and thus caused the heat to spread uniformly.

In this furnace, the aluminates and ferrites were burnt in the form of massive cylinders (see cut No. 16). When the melting temperature was obtained, the mass frequently fused all of a sudden, so that a special device had to be provided for quickly lowering the molten mass. At the same time, the progress of the burning had to be observed from above through blue glasses. By making use of magnesia tubes, which are made nowadays to withstand a temperature up to 3000 centigrade, very high temperatures can undoubtedly be obtained with this furnace. A test made with magnesia crucible, however, showed that even this material has some disadvantages, as the crucible shrunk in volume and split while being heated. But I must admit that the crucible was exposed at once to the intense heat of the arc-light and thus heated very suddenly, whereas placing of the crucible in the cold furnace and gradual heating would have caused a more uniform distribution of heat.

(To be Continued.)

New York Cement Show
December 14-20, 1910.

Chicago Cement Show
February 17-23, 1911.

THE BEHAVIOR OF HYDRAULIC COMPOUNDS IN SEA WATER.

By H. Buchartz.

One of the most important matters in building construction is the behavior of hydraulic compounds, particularly of Portland cement, in sea water, for numer-

ous sea-water structures have been built of mortar and concrete made of cement or other hydraulic compounds, such as hydraulic lime, trass, etc. The question, whether or not such buildings are endangered by the chemical or mechanical action of the sea water, was considered in 1896 by the German cement specialist, Dr. W. Michaelis; in his opinion the free lime in the

TABLE 1.—PROPERTIES OF CEMENT USED IN THE TESTS

CEMENT	CHEMICAL COMPOSITION			SPECIFIC GRAVITY		FINENESS			SETTING PROPERTIES		STRENGTH OF STANDARD MORTAR			
	Silica %	Alumina + Iron Oxide %	Lime %	Air-Dry	After being Ignited	Residue on Sieves with 5000a | 900b | 324c Meshes per sq. cm. % | % | %			Initial Set	Final Set	Tensile Strength 7 Days | 28 Days Lb. per sq. in.		Compressive Strength 7 Days | 28 Days Lb. per sq. ins.	
C Poor in lime	21.73	9.57	61.61	3.150	3.241	12.0	0.4	0.0	2 hours	6 hours 30 min.	290	360	2430	3500
Rich in lime	23.74	7.60	65.80	3.180	3.225	16.0	1.6	0.2	4 hours	9 hours 20 min.	350	450	3350	4620

a, sieve with 31,600 meshes per sq. in.; b, sieve with 5800 meshes per sq. in.; c, sieve with 2100 meshes per sq. in.

TABLE 2.—AVERAGE STRENGTHS OF MORTAR AND CONCRETE SPECIMENS MADE WITH CEMENT C

Kind of Storing	FRESH WATER						SEA WATER					
Time Stored in Sand	9 DAYS			1 YEAR				9 DAYS		1 YEAR		
Age of Samples	Tensile Strength in Lb. per Sq. In.	Compressive Strength in Lb. per Sq. In.		Tensile Strength in Lb. per Sq. In.	Compressive Strength in Lb. per Sq. In.		Tensile Strength in Lb. per Sq. In.	Compressive Strength in Lb. per Sq. In.		Tensile Strength in Lb. per Sq. In.	Compressive Strength in Lb. per Sq. In.	
		Mortar Cubes	Concrete Cubes		Mortar Cubes	Concrete Cubes		Mortar Cubes	Concrete Cubes		Mortar Cubes	Concrete Cubes
1 cement, 2 sand												
28 days	532	5830	4590	.....	.....	.....	538	5790	4500	.....	.....	.....
1 year	684	7000	6100	680	8190	6270	558	7500	6600	.....	.....	.....
5 years	740	7792	6760	810	9320	7350	640	8460	5800	615	9490	6800
1 cement, 4 sand												
28 days	290	3490	3230	.....	.....	.....	294	3430	2820	.....	.....	.....
1 year	365	3600	4300	453	4940	4440	322	4700	3760	.....	.....	.....
5 years	380	2960	4700	407	4720	4860	383	2870	4270	354	4630	5100
1 cement, 1 trass, 4 sand												
28 days	443	3870	3430	.....	.....	.....	534	4000	3500	.....	.....	.....
1 year	642	5800	5060	590	6680	5420	754	5690	5120	.....	.....	.....
5 years	680	6970	6100	764	8020	5790	587	6360	6290	666	7730	6380
1 1/2 cement, 1 trass, 5 sand												
28 days	507	459	3520	.....	.....	.....	600	4660	3700	.....	.....	.....
1 year	660	683	5570	593	7230	6000	733	6630	5580	.....	.....	.....
5 years	760	760	6290	760	9290	6160	582	6570	6400	756	9370	6190
1 cement, 1 trass, 8 sand												
28 days	229	1440	1430	.....	.....	.....	272	1730	1660	.....	.....	.....
1 year	300	2100	2800	346	3430	3120	342	2130	2920	.....	.....	.....
5 years	390	4630	3390	363	2840	3480	386	3000	3560	336	3050	3560
1 1/2 cement, 1 trass, 10 sand												
28 days	264	1990	2090	.....	.....	.....	307	2170	2190	.....	.....	.....
1 year	340	2400	3670	393	3660	3840	356	2360	3620	.....	.....	.....
5 years	422	3130	4040	514	4920	4170	393	2290	4000	519	5170	4220

Portland cement or the lime being freed in hardening combines with the sulphuric acid of the sea water which causes the mortar or cement to expand, resulting in its destruction. As proposed by Dr. Michaelis the action of the lime would be rendered harmless by adding to the mortar materials rich in silica which would combine with the lime, that is, puzzolanic materials, such as trass.

Dr. Michaelis' theories were ordered investigated by the Prussian Minister of Public Works, and a committee was appointed, consisting of representatives of the ministry, of the Royal Testing Laboratory, of the cement and trass industries, and Dr. Michaelis. The Royal Laboratory was placed in charge of the committee's investigations.

These tests were to determine the strength of cement mortars with and without the addition of trass as well as of trass-lime mortars with fresh and sea water. There were tested cements rich in lime, and poor in lime, and mortars to which had been added trass, and finely ground sand (quartz), in order to determine whether trass acts only mechanically (by increasing the density of the mortar) or chemically also. The results of these tests,

which will not be treated in detail here, show that the addition of certain puzzolanic materials to lean cement mortar mixtures is valuable in sea water.

On the basis of these test results a committee appointed by the Minister of Public Works in February, 1902, continued the investigations on concrete samples, especially on large bodies of concrete placed directly in dikes in the sea. The tests comprised mortar and concrete mixtures of cement, cement-trass and lime-trass and were to extend over a period of 30 years.

The tests were started according to the plan of the Royal Laboratory, with the assistance of the Royal "Wasserbau-Inspection" at Husum and have been concluded as far as the strength tests and observations of the five-year samples are concerned. The results have appeared in a report of the Royal Testing Laboratory, "Mitteilungen aus dem Kgl. Materialprüfungsamt."

According to this report, by Professor Gary and Mr. C. Schneider, the tests were conducted on two Portland cements, one rich in lime and one poor in lime. The following mortar mixtures were used and each specimen was made with $\frac{1}{2}$ part by volume of mortar to 1 volume of broken stone: (1) 100 cement: 200 sand; (2) 100 cement: 400 sand; (3) 50 cement: 50

TABLE 3.—AVERAGE STRENGTHS OF MORTAR AND CONCRETE SPECIMENS MADE WITH CEMENT A

Kind of Storing	FRESH WATER						SEA WATER					
	9 DAYS			1 YEAR			9 DAYS			1 YEAR		
	Tensile Strength in Lb. per Sq. In.		Compressive Strength in Lb. per Sq. In.		Tensile Strength in Lb. per Sq. In.		Compressive Strength in Lb. per Sq. In.		Tensile Strength in Lb. per Sq. In.		Compressive Strength in Lb. per Sq. In.	
Age of Samples												
	Mortar Cubes	Concrete Cubes		Mortar Cubes	Concrete Cubes		Mortar Cubes	Concrete Cubes		Mortar Cubes	Concrete Cubes	
1 cement, 2 sand												
28 days	572	6760	7040	.....	.....	.....	646	6790	7170	.....	.....	.....
1 year	722	7740	7540	710	8870	7500	750	7470	7400	.....	.....	.....
5 years	722	6320	7590	750	9530	7720	612	7620	7700	859	11900	7820
1 cement, 4 sand												
28 days	348	2990	3390	.....	.....	.....	362	2960	3520	.....	.....	.....
1 year	426	3400	3640	524	4890	4440	457	3660	3960	.....	.....	.....
5 years	362	3320	4030	439	3760	4340	369	3440	4420	442	4040	4440
1 cement, 1 trass, 4 sand												
28 days	504	3470	4290	.....	.....	.....	539	3030	4670	.....	.....	.....
1 year	616	5860	5520	622	5970	5820	749	5900	5340	.....	.....	.....
5 years	722	6300	5570	697	6040	5740	583	6560	5260	719	6440	6070
1 1/2 cement, trass, 5 sand												
28 days	573	5170	4870	.....	.....	.....	597	5400	4890	.....	.....	.....
1 year	640	7200	5670	617	6970	6100	672	7220	6120	.....	.....	.....
5 years	724	7230	6680	716	6690	6090	663	7570	6160	744	7140	6130
1 cement, 1 trass, 8 sand												
28 days	242	1560	2120	.....	.....	.....	292	1700	2140	.....	.....	.....
1 year	353	2420	2920	404	3400	3240	360	2690	2820	.....	.....	.....
5 years	399	2820	3230	370	2370	3060	394	2890	3090	344	2490	3120
1 1/2 cement, 1 trass, 10 sand												
28 days	240	1430	2140	.....	.....	.....	262	1430	2220	.....	.....	.....
1 year	320	2240	2790	347	2840	3260	324	2100	2760	.....	.....	.....
5 years	329	2220	3090	419	3020	3330	329	2240	2900	437	3260	3260

trass: 200 sand; (4) 60 cement: 40 trass: 200 sand; (5) 50 cement: 50 trass: 400 sand; (6) 60 cement: 40 trass: 200 sand; (7) 150 trass: 100 lime paste: 50 sand; (8) 150 trass: 100 lime paste: 100 sand.

The following tests were made: (1) Tensile and compressive strength of the mortars; samples of standard size; age, 28 days, one year and five years; samples hardened in fresh and salt water after preliminary storage under wet sand for nine days or one year. (2) Compressive strength of concrete mixtures, using 12-in. cubes, having same age and hardening treatment as the mortars. (3) Behavior of large concrete masses of the size and shape used for dikes; some specimens were placed in a dike after three months, and some after one year's storage in wet sand. (4) Permeability of the mortar; using both disks 7.1 cm (2.8 in.) in diameter and 3 cm (1.18 in.) thick and the so-called Paris cylinders, (according to the Le Chatelier method). (5) General properties of the mortar and concrete materials.

The specimens were made in Westerland, on the island of Sylt. The mortar and concrete samples were stored in tanks; the concrete blocks, after the prescribed sand storage, were placed as covering stone in finished coast dikes where they were continually exposed to the chemical and mechanical action of the sea. The cements used were standard slow-setting Portland cements. Their physical properties are shown in Table 1.

The trass was taken from the Nette Valley; the mixtures contained 25 per cent blue, 25 per cent gray, 50 per cent yellow trass. The sand was taken from the downs of the island and screened through a 20-mesh sieve. The broken stone was Swedish granite.

The tests were partly executed on the island, at Westerland, in the laboratory of the Society of German Portland Cement Manufacturers, and partly in the Royal Testing Laboratory at Gross Lichterfelde. The results obtained from the strength tests are given in Tables 2 to 4. They represent the average values of 5 or 10 individual tests.

A record of the observed results of the concrete blocks placed in the dikes cannot be given here, but the general result of these investigations is contained in the final conclusions given below.

From the results of the strength tests and the inspection of the concrete blocks Messrs. Gary and

Schneider draw substantially the following conclusions:

Cement and Cement-Trass—Cement C.—The addition of trass to rich mortar in fresh water decreases its tensile and compressive strength during the initial period of hardening, but as the samples age the trass has the effect of improving them. The same result was noted in the case of concrete mixtures.

Samples of the same mixtures hardened in sea water behave differently. The addition of trass improves the tensile strength of the mortar, but the tensile strength of the five-year mortar samples with trass decreases a little. The compressive strength of mortars and concrete in sea water is reduced by the addition of trass as is the case with samples in fresh water.

The poor mixtures of cement C behave differently from the rich mixtures.

The tensile strength of the samples stored in fresh water is favorably influenced by the addition of trass. In the beginning the mortars with trass show a lower strength and later a higher strength than those without trass. The relations of the compressive strength of both mortar and concrete show similar results. It is remarkable that the mixtures with trass increase proportionately more in strength than those without trass. The most favorable behavior is shown by mortar and concrete containing $\frac{1}{2}$ cement, $\frac{1}{2}$ trass and 4 sand.

The strengths of the samples in sea water are generally about the same as those in fresh water and differences are not worth mentioning.

Cement A.—Cement A shows quite different results. Although the tensile and compressive strengths of the mortar and the concrete samples in fresh water are the same as those of the rich mixtures of the mortar of cement C, a comparison of the fresh water and sea water samples shows considerable differences. The rich mortar, 1:2, of cement A without the addition of trass hardens approximately uniformly in fresh and sea water. If trass is added the mortars harden better in sea water, and concrete mixtures about the same as the same mixtures in fresh water. This means that the addition of trass in the case of hardening in sea water is successful.

Nearly the same applies to the poor mixture, 1:4. The lean mortars with trass harden better in sea water, and the concrete nearly as well as the same mixture in fresh water.

TABLE 4.—AVERAGE STRENGTHS OF MORTAR AND CONCRETE SPECIMENS MADE WITH TRASS LIME

Kind of Storing	FRESH WATER						SEA WATER					
Time Stored in Sand	9 DAYS			1 YEAR			9 DAYS			1 YEAR		
Age of Samples	Tensile Strength in Lb. per Sq. In.	Compressive Strength in Lb. per Sq. In.		Tensile Strength in Lb. per Sq. In.	Compressive Strength in Lb. per Sq. In.		Tensile Strength in Lb. per Sq. In.	Compressive Strength in Lb. per Sq. In.		Tensile Strength in Lb. per Sq. In.	Compressive Strength in Lb. per Sq. In.	
		Mortar Cubes	Concrete Cubes		Mortar Cubes	Concrete Cubes		Mortar Cubes	Concrete Cubes		Mortar Cubes	Concrete Cubes
3 trass. 2 lime,* 1 sand												
28 days	216	800	1170	.....	.....	.....	229	800	1240	.....	.....	.....
1 year	356	2740	2720	412	2940	2720	330	2560	2760	.....	.....	.....
5 years	400	2990	3220	330	2790	2960	456	2830	3240	339	2440	2970
1 1/2 trass, 1 lime.* 1 sand												
28 days	244	1330	1630	.....	.....	.....	306	1430	1700	.....	.....	.....
1 year	383	2330	2790	454	2400	2540	366	2300	2400	.....	.....	.....
5 years	360	2790	2620	400	3040	2620	356	2860	2530	464	3190	2670

* Hydrated lime (paste)

The fact that cement **A** has generally given higher strengths than cement **C** is due to its greater content of lime and its better manufacture. In comparing the results of the samples which have been stored nine days and one year, respectively, in sand before being exposed to the fresh or sea water, it appears that the mortar and concrete mixtures (of cement **C**) which were stored for the longer period have shown uniformly higher strengths in fresh water, while in sea water this is not so true, though the compressive strengths are higher than the equal mixtures with only nine days' storage. With cement **A** a normal behavior of all mixtures with samples five years old cannot yet be ascertained. Whether the test of older samples will show differences in this respect remains to be seen.

Trass-Lime—The difference between the strengths of mortar and concrete mixtures with trass-lime is slight. This is due to the fact that both mixtures, although they vary considerably in the contents of sand, still possess an ample excess and therefore are very dense.

The strength of mortar and concrete increases considerably and regularly up to one year's age; later on the increase of strength is only slight. In rich and in lean mortar trass-lime acts uniformly with fresh and sea water hardening. Mortar and concrete show, as was to be expected, nearly similar increase of strength. Only in the lean concrete the addition of broken stone seems to have caused a certain porosity so that the strength decreases after longer hardening.

Concrete Blocks Made With Cement and Cement-Trass.—The difference of the cements **C** and **A** appears more distinctly in the larger blocks than in the smaller samples stored in quiet water. The blocks of cement **C** of the richer mixtures show with few exceptions fine cracks and surface damages, which fact shows the favorable effect of the addition of trass and of the longer storage under sand. However, all blocks of the rich mixtures of cement **A** have remained unchanged with the exception of four blocks having proportions of 1 cement: 1 trass: 4 sand, which, before placing, were stored under sand for three months only and the surface of which was attacked after one year in the dikes. The blocks of the same mixture stored in sand one year before placing in the dikes show, with one exception no damage.

With the mixture of 1 cement: 4 sand all blocks of cement **A** stored one year in sand, remained sound, while the corresponding blocks stored under sand for only three months showed, during the time of observation, superficial damages, especially on the edges. The remaining blocks of all the poor mixtures have been more or less damaged, the blocks made of cement **C** more so than those of cement **A**.

The blocks of a mixture of 1 cement **C** and 4 sand, containing no trass, show the greatest damage, and a comparison with the corresponding blocks of the mixtures with trass shows the favorable effect of the trass added to the poor mixtures.

The blocks of cement **A** generally show a favorable behavior although they too are badly damaged. The addition of trass to cement **A** does not make any difference with these blocks.

Concrete Blocks Made with Trass-Lime.—Blocks made of rich trass-lime concrete are mechanically attacked on the surface by the surf and sand, but do not show chemical decomposition. Storage for three months under wet sand before placing them in sea water is sufficient to make blocks of this mixture resistant to the action of the sea.

The blocks of poor trass-lime concrete behave somewhat differently. Those stored under wet sand for only three months, sustained considerable surface dam-

age after one to two years, while the blocks embedded in sand for one year before placing them in the dikes showed the same resistance as those of the rich mixtures.

Summary: The outcome of these tests, therefore, is that Portland cement can be greatly improved by admixtures of certain puzzolanas, and that, for marine construction, such an admixture becomes imperative, unless the builder chooses to use, instead of a puzzolana-cement concrete of the ordinary proportions, a Portland cement concrete very much richer in cement than customary nowadays, which would greatly increase the cost of the construction.

NOTES ON THE FAILURE OF STUCCO WORK

A number of years ago stucco was quite generally used in certain localities, but owing to failures of the material to withstand the action of the elements and other causes, this type of construction was almost entirely abandoned. During the last few years, however, there has been a very marked tendency by the building public to take up this class of construction again, therefore this word of caution.

We do not want to have the same experience with this type of construction, as the concrete block industry has had, and yet unless due care is used in drawing specifications and in their application, there are going to be a great many failures as in the past. Our architectural friends are very partial to stucco exterior, and if it is properly mixed and applied will come up to their expectations in every way. So much depends on the selection of the material, proper mixing and proper application that only skilled mechanics who are familiar with this class of work should be employed.

The writer has had opportunities to inspect a great many stucco residences in the past few years and is very sorry to say that the greater percentage of them are unsightly, due to cracks, discolorations caused by improper application, and lack of proper ingredients, etc. I wish to illustrate briefly by stating facts regarding two or three of the houses that have come to my attention.

I remember one residence in particular, where there were a great many horizontal cracks in the stucco running almost the entire length of one side of the building. These cracks were about two feet apart and were very pronounced. The whole area of sides and ends was very unsightly. After a very careful investigation it was found that in nearly every instance where cracks had developed that they were at a point where the wire lath was lapped and in many places less than $\frac{1}{4}$ -inch thickness of stucco was over these laps. In some instances by cutting out the cracks it was found that the metal lath was not even tacked solidly in place, and yet stucco work in general was condemned by a number of parties on the results obtained on this one building. It was quite apparent that the trouble was not due to any fault of the material, but in this particular instance was due entirely to the application of the wire lath and stucco. In addition to the large cracks at the laps of the wire lath, there were a number of hair cracks throughout the entire area, which apparently were caused by too much trowelling of the concrete mass, and as was found by investigation there was a coating or frosting of Portland cement on some of the areas and the cracks penetrated just through this frosting. Other areas were entirely smooth and cracks had not developed.

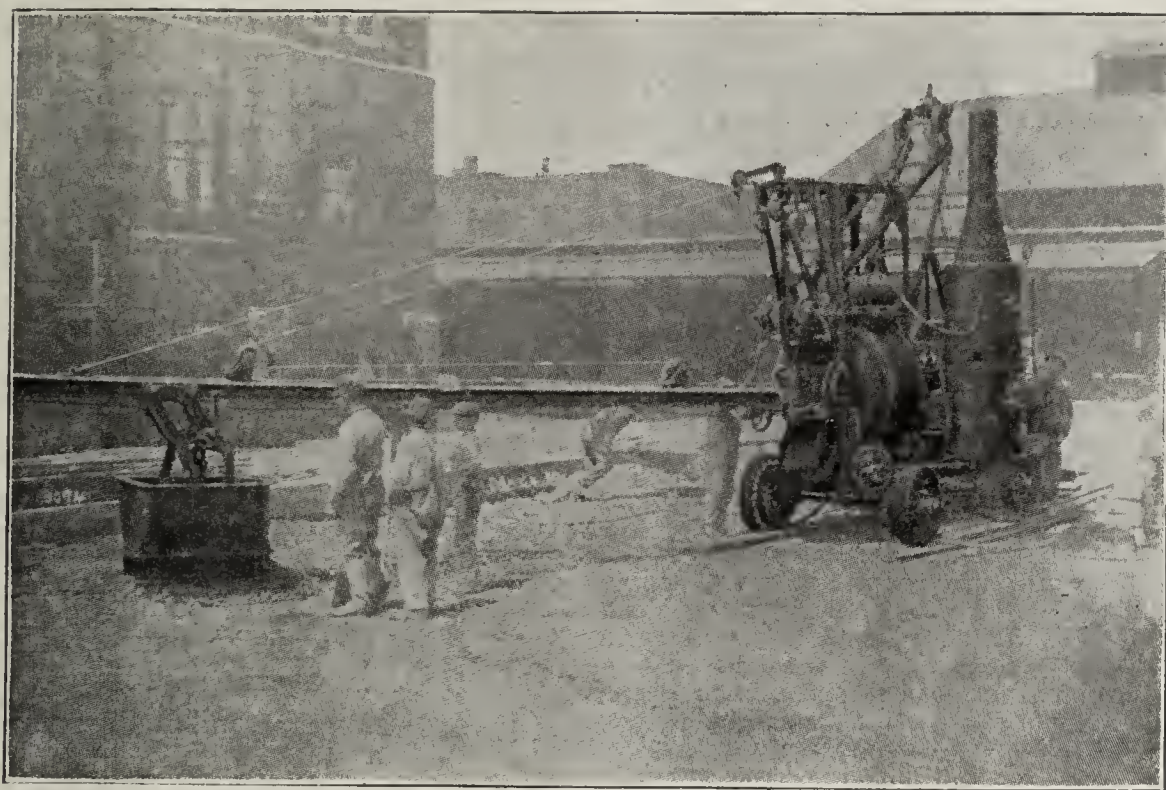
In another case regular lime mortar plaster without any Portland cement was used for the scratch coat.

The second and finishing coat consisted of a poor mixture of Portland cement and sand. The finish coat was only about $\frac{1}{4}$ -inch thick. Moisture penetrated through the finish coat and the mortar composing the scratch coat being subjected to continued moisture, disintegrated and the stucco came off in sheets.

The third case was very similar to the second, although wood lath was used instead of wire lath on a small building near the seashore. The scratch coat material consisted of regular interior plaster and the second coat consisted of Portland cement, asbestos rock and asbestos fibre. The second coat was very thin and the damp salt air and moisture penetrated through to the first coat. The lath became swelled and the stucco came off in sheets. The stucco on this work was condemned and the faults were laid at the door of the asbestos and Portland cement. Upon investigating the matter thoroughly, it was readily proven that the entire trouble was due to the nature of the lath and the materials entering into the first coat.

completed condition half way between windows or half way down the side walls, for just as certain as this is done, there will be a streak showing where the later work was started. If it is necessary to do a certain given area at two operations, care should be used to get the materials properly blended and the new stucco floated or trowelled to correspond exactly to that already done. By using a little care on details of this kind the ultimate results will be much more satisfactory.

Portland cement and sand as a stucco mixture has been used with fair success where the work has been carefully supervised, but there has been such a lack of proper attention to the mixing and application that there have been some very bad failures. The use of asbestos rock and fibre to take the place of sand is meeting with considerable success. The asbestos fibres have a tendency to hold the water which is used to mix the concrete mass, longer, thus giving the Portland cement ample opportunity to become properly set and in this way stucco mixtures are possible that are



A LABOR SAVING CONCRETE CARRIER,

Manufactured by The Koehring Concrete Mixer Co., Milwaukee, Wis.

I have referred to these buildings with a view to cautioning people interested in stucco construction to see that this particular part of the building is given proper attention. In the past stucco has been applied in two coats, the total thickness being about $\frac{1}{2}$ -inch to $\frac{5}{8}$ -inch. Past experience is teaching us, however, that 1-inch is by far better and if the material is applied in this thickness, house owners and architects should not have reason to regret its use.

Another point of considerable importance is the color. A uniform color is rather difficult to obtain, on smooth surfaces particularly, but it can be obtained if proper attention is given to the selection and mixing of the ingredients and if the stucco is properly applied. When Portland cement and sand are used it is very essential that the sand should be absolutely free from any organic materials which have a tendency to discolor. It is also of vast importance that the ingredients be mixed very accurately and carefully and that a sufficient amount be mixed at one time to cover certain areas exposed to the same lights and shadows.

For example, the work should not be left in an un-

more uniform in color and less liable to crack as the fibre also furnishes additional bond.

There is one point which is frequently lost sight of, that is that it is possible to manufacture or make concrete slabs that are free from cracks and that can be exposed to the elements for an indefinite period without discoloration. Therefore, should cracks develop in a well constructed stucco work it can be invariably traced to settling of the building or the shrinking of the frame. By insisting upon thicker stucco walls the liability of the stucco cracking is reduced to a minimum.

The price of lumber is steadily advancing and the desire for fireproof exteriors, especially in the suburban districts as well as artistic effects that may be obtained from stucco are creating a universal demand for this type of construction, and while the initial cost may be slightly more it is such a small part of the total outlay and such an important part of the structure that the best is the cheapest in the end.—Engineering-Contracting.

A LABOR SAVING CONCRETE CARRIER.

A new feature of the Koehring concrete mixer is attracting considerable attention among paving contractors. This innovation is of a nature that its value will be at once apparent. It consists of a delivering carrier to take the concrete from the machine and deposit it at will upon the street surface, saving by its operation the labor of seven men.

The carrier consists of a 20-foot beam attached to the machine in such a way that it may be raised or lowered and may be swung in an arc of 90 degrees about its fixed end. Upon this beam is swung a steel carrier with a double door bottom dump. This carrier is arranged on rollers so that it may be moved out along the beam by means of a cable operating over a reversible drum.

The method of operation is simple in extreme and requires only two men on the entire mixer force. One man takes care of the charging and another operates the discharge and delivery of the mixture. The carrier bucket is filled and moved out along the beam to the required position where a laborer whose work it is to spread the concrete, dumps the charge. The return of the carrier helps, in a degree, to spread the concrete, thus aiding the men allotted to this work.

The accompanying photograph shows one of the machines in operation. This particular machine has a record of 80,000 yards laid, some of which was put in place at a cost as low as 4 3-10 cents per yard. Full catalogues and prices of the machines may be had of the Koehring Machine Co., 614 Germania Bldg., Milwaukee, Wis.

MACHINE vs. HAND-MIXED CONCRETE.

By C. W. Gaylord, C. E.

You want to know the inside facts—not guess work—nor along general conclusions, but the process step by step in the mixing of concrete as you would take it in your every day work.

Every worker in concrete will appreciate the comparison which we make between the two processes—hand-mixing, against machine mixing—and as a business proposition the question is not so much whether you can afford not to buy one.

To be thoroughly understood, an analysis is made of the different operations, which must be performed in mixing concrete, to determine:

(a)—Which method is cheapest.

(b)—Which method gets the best results.

To mix concrete the following operations must be gone through, regardless of the means of mixing:

(1)—Materials must be loaded into some means of conveyance.

(2)—Materials must be transported to place of mixing.

(3)—Materials must be measured to obtain proper proportion.

(4)—The materials must be mixed together.

(5)—The finished concrete must be loaded into some conveyor for transportation.

(6)—The concrete must be transported, spread and rammed into place.

In addition to the above in the consideration of cost, there must be included the item of attending to the water, the supervision and cost of plant.

It is the contractor combining the above operations into the fewest moves that is the most successful. The

use of a mixer of the type of the Miracle Positive Feed Mixer absolutely combines items (3) and (4) and under intelligent use, practically reduces items (2) and (5) to nothing. Take a comparison of cost of hand and machine mixing with careful analysis of the above conditions.

Actual cost of hand mixing of concrete under favorable conditions in Riverside, Cal., during 1909. Concrete placed in six-inch wall. Labor, efficient and experienced. The crew consisted of:

Foreman	\$ 3.00 per day
Two men at \$2.25.....	4.50 per day
Eight men at \$2.00.....	16.00 per day

Total\$23.50 per day.

This crew averaged twelve batches of concrete per nine-hour day, each batch containing 1.7 cubic yards, or 20.4 cubic yards per day. The material handled was:

84 Sacks cement;

9.8 Cubic yards sand;

19.6 Cubic yards stone, 1½ inches and under.

This is over two cubic yards, per man, per nine-hour day, of finished concrete, including all work except forms. The average given by most authorities is from 1¼ to 1¾ cubic yards per man, per ten-hour day. This shows the ability and efficiency of this foreman and crew, and proves this to be a very pertinent case to compare with machine mixing.

The cost of mixing and placing, per cubic yard, was \$23.50 divided by 20.4 equals—\$1.15 per cubic yard.

This was divided into the respective operations as follows:

(1)—Loading on wheelbarrows:

Sand, .46 cu. yds. at 10c per yd.....\$0.05

Stone, .92 cu. yds. at 15c per yd..... .14

(2-3)—Wheeling to mixing board and dumping in measuring box:

Cement (all handling)..... .04

Sand, average haul 30 ft..... .02

Stone, average haul 50 ft..... .05

(4)—a) Mixing sand and cement, 2 turning..... .12

b) Mixing mortar with stone, 3 turnings.... .27

(5)—Loading concrete into wheelbarrows..... .17

(6)—a) Wheeling to place, average haul 55 ft... .06

b) Dumping, spreading and ramming..... .11

(7)—a) Supervision, ⅓ of foreman's time charged in above items..... .10

b) Care for water..... .02

\$1.15

To this must be added the cost of the mixing boards, 2 of which were necessary, and which lasted for about 500 cu. yds. before becoming so rough that it was 2 16 ft. by 16 ft. boards, 500 B. M. at \$40.00 per 1000 B. M. for lumber and making, \$20.00; \$20.00 divided by 500 .04

Total cost of 1 cu. yd.....\$1.19

Under exactly similar conditions, the cost of one cubic yard for machine mixed concrete would be as follows:

(Note—The same names are given to the various items for clarity, although slightly different operations are performed, as noted.)

(1)—Loading on wheelbarrows:

Sand

.....\$.05

Stone*

..... .14

(2-3)—Wheeling to mixing board and dumping in measuring boxes:	
Cement	
Sand.....	.04
Stone*.....	.02
	.00
(4)—a) Mixing sand and cement.....	.09
b) Mixing stone with mortar.....	.00

34

Note—This is made up as follows:

One man handling mixer, dumping concrete, tending water, etc., at \$3.00 per day.	
Estimated number cu. yds. per day, average, 40 cu. yds.	
Cost of mixing per cu. yd.:	
Labor, \$3.00 divided by 40....	.075
Gasoline, per cu. yd.....	.015
	.09
(5)—Loading concrete into wheelbarrows.....	.02
No shoveling here, just pulling a lever.	
(6)—a) Wheeling to place.....	.06
b) Dumping, spreading and ramming.....	.11
(7)—a) Supervision: $\frac{1}{3}$ of foreman's time charged in above items, at 40 cu. yds. per day, \$2.00 divided by 40.....	.05
b) Care of water.....	.00
Charged in under item 4.	
Cost without plant.....	\$0.58

*Note—The stone is not loaded on a barrow but shoveled into the hopper of the mixer direct. The mixer being on wheels, it is a very simple matter to keep moving along as the stone pile is being used up. This is impractical with hand mixing, as there is generally part of the previous batch on the board when a new batch is started and the trouble to move and block up the board is greater than the saving in the handling of the stone.

To this must be added the cost of plant,	
$\frac{1}{2}$ estimated life of a Miracle	
Absolute Feed Mixer, cu. yds. 10,000	
Cost	\$600.00
Repairs during use for 10,000 yards..	200.00
	\$800.00
Salvage in Mixer.....	100.00
Cost for 10,000 cu. yds.....	\$700.00
Cost per cu. yd. is \$700.00 divided by	
10,000	.07
Total cost per cu. yd.....	\$0.65

This means a saving of 54 cents on every cubic yard of concrete mixed; a saving of over 45 per cent.

A question is always raised here by the adherent to the old fashioned hand mixing: "But how about the man who uses only 2000 to 3000 cubic yards of concrete per year? He would have to wait four years and use his machine for that length of time before he gets the full advantage of the 54 cents per cubic yard saving. He might not be in business by that time." Figure the saving from another point of view. Say, the user produces 2500 cubic yards per annum. The difference between hand and machine mixing, without considering the cost of machine, is \$1.19—.58—61c saving; 2500x.61—\$1525. Deducting from \$1525 the cost of the machine,

\$600, and there is a saving for one year of \$925, 150 per cent of the cost of the machine. The machine operated the second year the \$1525 is all saved, less the cost of repairs and maintenance to the mixer. One does not have to figure four years. The mixer has paid for itself the first year twice over.

So much for the relative cost of hand and machine mixed concrete. As to the relative value of hand and machine mixed concrete, there is no disputing the advantage of the machine mixture over even the most carefully mixed hand product. Most authorities give the strength of the machine mixture as 15 per cent to 20 per cent more than a hand mixed concrete. Some give even 25 per cent and quote from carefully conducted tests to bear them out. This is considering carefully hand mixed concrete. No wonder the engineers and architects are deploring the element of "personal equation" that enters so prominently into most concrete work. To limit this as far as possible, mixers are now always specified to be used on work of any importance. Even if it was not an actual saving, it would be cheap as good insurance against failure due to careless mixing. It means that the full value of the cement used will be developed. No cement is wasted.

It is the old story of physical labor vs. machinery, and the truth of the above cannot be more forcibly stated than by the saying so well known to the trade—"Once a mixer, always a mixer."

EXPERIMENTS IN COLORING CONCRETE.

By Prof. Charles E. Pellew.

Some two months ago I was asked by a prominent architect of my acquaintance to examine for him the general subject of coloring concrete for building purposes. My friend is engaged on the problem of constructing a large number of workingmen's cottages near the city of New York, and has decided that concrete, when used scientifically as a building material, possesses great advantages over wood, stone or brick as regards durability, freedom from fire, comfort, and even expense. But the natural color of concrete is not particularly interesting, and, to get satisfactory results from an artistic standpoint, it was evidently necessary to have it colored in one way or another.

The experiments which we have been making on the subject are not yet complete, and, indeed, probably will not be quite finished for some months yet. But the question of coloring concrete is such an interesting one, and promises in the near future to be of such importance that we have been requested to present the results so far obtained to the readers of the "Craftsman" without waiting for the work to be entirely completed.

The general problem of coloring concrete naturally separates itself into two main divisions, Body Coloring and Surface Coloring. In the first the pigment is incorporated in the body of the concrete before mixing, and forms blocks of even color all through. In Surface Coloring, on the other hand, the coloring material is applied to the surface of the block, after the concrete has set, and thus forms only a thin film or coating on the outside.

These methods of applying the color each have their special disadvantages, due to the nature of the material. The free lime in the concrete has, when moist, a strong and generally injurious chemical action upon most of the ordinary pigments, and comparatively few coloring matters are able to resist it, especially when mixed right in with it. It has at the same time a strong action upon many kinds of organic matter, such as linseed oil, used in paint. Then, too, the compact, but friable surface of concrete makes it difficult to force a

stain or paint into the pores far enough to prevent it from being easily brushed or rubbed off.

For our particular problem, as it happened, the question of expense was of vital importance; and this limited us still further in our range of possible pigments. In the matter of first cost it is evident that some form of surface coloring would be cheapest. But, unless great pains are taken to have a thoroughly hard, permanent surface for the pigments to adhere to, and to obviate as far as possible the use of linseed oil, the Body Coloring is probably the most satisfactory.

In this paper we propose to sketch, briefly, the various materials that can be used for Body Coloring, and later, to discuss the different methods of Surface Coloring by stains, paints, etc. Our experiments hitherto have been directed toward the following colors: brown, red, yellow, buff, black and green, and we shall take them up in that order:—

Brown.—Some experiments with a vegetable brown made from partially carbonized organic matter gave results which were unsatisfactory, as the colors were hard and uninteresting. We then made a series of experiments with two mineral dyestuffs, long known and used for staining and coloring textiles, but not, we believe, used hitherto for coloring cement or concrete. These were the orange-brown iron-rust color and the manganese brown.

A. Iron-Rust.—This color is the same as that known to our ancestors for dyeing homespuns, and is still used for coloring fishing boat sails on the Mediterranean. It is based on the formation in the concrete of a reddish brown deposit of ferric hydroxide by the action of the lime of the cement on a soluble salt of iron, like ferric chloride or ferric sulphate. First we tried ferric chloride as the coloring agent, but we found later that strong solutions of ferric sulphate could be obtained from the chemical manufacturers at a low price, 1.5 to 1.6 cents a pound, far less than any other soluble ferric salt.

Unfortunately, it takes a very large amount, 25 to 30 per cent. (of the weight of concrete) to get at all a decided color with this compound, and this is a serious drawback for our purposes.

B. Manganese Brown.—This color is based on the formation in the concrete of brown manganese hydroxide by the reduction of the salt potassium permanganate. The latter possesses a strong rich purple color, which in the presence of oxidizable material, such as organic matter, turns at once to a full seal brown.

This reaction has been known and used for a long time in the dyeing of textiles, and an interesting application of it was made in England some ten years ago during the Boer War. It was necessary to send to the front all the available troops, and among others the famous old cavalry regiment, "The Scots Greys," renowned for glorious records at Waterloo and elsewhere, was called out for service in South Africa. Ever since its formation, some two hundred years ago, this regiment has been mounted on white or grey horses, and it was strongly hinted to the War Department that it was foolish to dress the cavalymen with the utmost care in dull khaki and to carefully paint brown all metal work, from their sword hilts and stirrups down to belt buckles and uniform buttons, and yet to have them ride horses of such a conspicuous color. There was no time to train new mounts for them, so an eminent dyeing chemist was consulted, and he advised sponging over the horses every morning on the voyage down with a weak solution of permanganate. The results were most satisfactory, and long before they reached the Cape each horse was thoroughly stained a quiet, soft, brown shade.

In dyeing textiles the organic matter needed for the reaction is taken from the cloth or yarn itself, and care must be taken not to "tender" it in the process. In staining concrete the organic matter must be supplied in the form of glucose or sugar, which in quite small quantities will change the deep purple color of the permanganate into a rich seal brown. To get a full, deep color in our experiments we were obliged to use some 24½ per cent. (by weight of the cement) of permanganate and about ½ per cent. of glucose. The price of permanganate is about eight cents a pound, and the glucose can be obtained in the form of a thick, concentrated syrup at a little less than three cents a pound.

Red.—The only red colors practically available for Body Coloring are the various forms of red oxide or iron, some of them natural, finely ground hematites from Europe or this country, and others artificial, usually a residue from the distillation of copperas for fuming sulphuric acid.

These colors differ greatly in shade, price and coloring power, and it is impossible to cover more than a few of the innumerable varieties of red oxide that can be obtained for this purpose. In general, the cheaper colors are either native oxides of rather unsatisfactory shades and low coloring power, or else are more expensive and powerful pigments mixed with a neutral adulterant, like gypsum. As a pigment adds nothing to, and indeed, distinctly detracts from, the strength of the concrete, it is evidently best to get the desired shades by a small amount of a strong, though high-priced, color than by using a cheap and weak color in proportionately larger quantities.

After experimenting with twenty or more different colors from various manufacturers the best results were obtained from a red color at five cents a pound, from 7½ to 10 per cent. (of the weight of cement) being needed to give a full shade. The addition of small amounts of permanganate brown, as described above, modifies the bright red color and gives a more pleasing shade, like red terra cotta.

Yellow.—For this color the only available pigment is some form of yellow ochre, which can be obtained both strong and cheap. The best results that we have had came from the use of a strong, bright color, price 2½ cents, which, when used to the extent of 8 per cent. of the cement, gave a bright tan color. This yellow can be used for shading the red, but is not so effective for this as the manganese brown.

Buff.—The same yellow ochre, when mixed with small amounts of the permanganate brown, will give various shades of yellowish brown or buff color. Pleasant shades are obtained by using 5 per cent. of yellow ochre and 2½ per cent. of permanganate.

Black.—In case black shades are desired, they can be obtained without difficulty by using some of the carbon or lampblacks, sold by the manufacturers for 1½ cents a pound and upward. For a bluish shade of black we experimented with some success with a black iron oxide, imported for the use of gas works at 1¾ or 2 cents a pound. Full shades would need some 8 or 10 per cent. of the pigment.

Green.—The high price of chromium oxide, the only green mineral pigment which will stand the action of lime, prevents its use for body coloring. Good qualities of chromium oxide cost from 40 cents a pound upward, and while cheaper grades are in the market, their coloring value is, as a rule, proportionately lower.

In the absence of a strong blue which will stand the action of lime, it is not possible to obtain a good green by modifying the color produced by yellow ochre. Ultra-marine blue is, indeed, fast to lime; but possesses a very low coloring power when mixed with other pig-

ments, while the strong blue, Prussian blue, which is commonly used as a constituent of green paints, is very easily attacked by the cement.

It is sometimes possible, with light colored materials, to obtain pleasant shades of olive green by mixing yellow ochre with black pigments, if the latter have a tendency to bluish black. We made several experiments to see if this was possible with concrete, using both carbon black and the black iron oxide just mentioned for the purpose. Unfortunately, the color of the natural concrete was such that none of these experiments gave any satisfactory results.

It seems probable that for greens we must depend upon some form of Surface Coloring and not of Body Coloring; that is, if we are to use ordinary cement and sand and gravel of the usual brown shade. By using the more expensive white cement and crushed blue-stone of assorted sizes for sand and gravel, it is probable that pleasing effects can be obtained with the above combination. With the ordinary materials, however, the color was killed.

A METHOD FOR LONG SPAN, LIGHT FLOOR; REINFORCED CONCRETE CONSTRUCTION, WITH COMPARATIVE COST.

Emile G. Perrot.

While there has been no doubt of the economy and practicality of reinforced concrete for massive construction and where heavy loads are carried, the advisability of its use for light floor loads, especially if the spans are long, has been questioned even by those who favor its use in other instances. The dead weight of the material itself has often operated against its use, especially where the carrying capacity of the soil required the unit pressure to be kept to the minimum, or from other like causes.

We all agree that clear spans of forty or fifty feet in buildings are not usual and are generally avoided on account of their increased cost; hence a description of such a span, with its cost as compared with steel girder construction for the same span, is of interest.

While the author does not wish to take any credit for originality in the design of this floor, as the same general scheme has been used many times before for shorter spans, it is because of the usual length of the span that its details become an important factor in the design.

The spans in question form the floors over the swimming pool and gymnasium of the Turngemeinde Club house, Philadelphia, and are 53 feet 17/8 inches clear span.

There are two floors with these spans, of an area of about 4,700 square feet each, having five girders on the first floor and six on the second floor, spaced 13 feet 9 inches centers. Those of the first floor are only 36 inches deep below the joist, on account of head room. The top portion, or T-head, is 5 feet 4 inches wide and 14 inches thick. These girders are reinforced with twenty-one 1 1/8-inch square twisted bars. The stirrups are 1x1/8-inch flat iron.

Great care was taken to place the bars accurately in position, and the bottom bars were supported in the bottom of the moulds on cast cement chairs, while the spacing of the bars and stirrup was maintained by iron rods and the wiring of one bar to the other.

The floor panels between the girders consist of 5x12-inch concrete joists, with a 2-inch reinforced concrete slab over same, and 12x12 plaster block centers between

each joist, thus making a flat ceiling between girders. The joists are reinforced with one 11-16-inch square twisted bars and eight 1/4-inch stirrups. In the top of every third joist were placed two 3/4-inch square twisted bars over the girders to act as tie. These rods were only five feet long but two were used in each case, lapped in the center so as to project beyond the T head into the joists. The slab is reinforced with 1/4-inch rods run in both directions, 12 inches on centers or thereabouts.

The girders supporting the auditorium floor, on account of the higher ceiling, are 42 inches deep, with T head, 4 feet 9 inches wide. The reinforcement in the bottom consists of eighteen 1 1/8-inch square twisted bars.

Each floor is designed for a live load of 120 pounds per square foot, as the top floor is an auditorium and the floor below a gymnasium.

There seemed to be some doubt amongst the members of the Building committee as to the advisability of constructing such long span of reinforced concrete, and one of the committee went so far as to offer to increase his subscription to the building fund by a very large amount, in order to pay for steel girders, but the amount offered was insufficient to pay the extra cost, so the girders were built as originally designed, of reinforced concrete. In order to obtain the actual difference in cost, we designed the girders of Bethlehem steel girder sections, reinforced with top and bottom cover plates and fire-proofed as shown in the illustration. The size of the steel girders was 30 inches deep, one 5/8x15 inches and one 1/2x15 inches. We obtained bids from the building contractor for the difference in cost of these girders, we having likewise made an estimate of the difference in cost. The contractor's price for them was \$6,500 additional to his contract price, although our estimate of the difference was somewhat less, being \$4,664, based on prices obtained from outside sources. Taking our figures as a basis, as there are 5,400 square feet in the two floors, the difference in cost for the structural steel, fireproofed, is 50 cents a square foot more than the reinforced concrete, with no increased advantage.

The weight of the structural steel for a girder as compared to the weight of reinforcing steel is as follows:

Total weight of steel girders, with strap iron reinforcement for fireproofing and bearing plate, about 17,000 pounds.

Total weight of steel girders, with strap iron reinforcement concrete girder, 36 inches deep, 5,500 pounds.

This shows that it takes about one-third the amount of the steel for reinforced concrete as compared with structural steel for girders and beams. The amount of saving in concrete would be the overhanging portions of the T head, which amounts to 2 1/4 yards per beam, when the extra thickness of concrete on the girders is taken into account due to the wide flanges on the steel girders; likewise there would be additional plaster blocks necessary to take place of the T head omitted, the cost of which would have to be deducted from the saving effected by omitting the T head.

The sub-contractor for the reinforced concrete work gave the cost of the plaster blocks, delivered at the job, as 14 cents per square foot, and setting of same, including the nailing on of a fine wire screen at each end to prevent the concrete running into the hollow part of the block, as three cents a square foot additional.

The plaster block weighs 25 pounds per square foot, as compared with 40 pounds per square foot for terra cotta tile, which cost the same price as the plaster block but which are not as easily handled, being only 12 inches long, whereas the plaster blocks are 3 feet long and can be sawed to fit any position.

The walls of plaster blocks are about $1\frac{1}{2}$ inches thick, and there are two cells in each block, separated by a vertical wall in the middle which strengthens the block, so that traffic can take place over them before and during the time of pouring the concrete.

Immediately before pouring the concrete it is necessary to thoroughly soak with water the plaster blocks, as they absorb a considerable quantity of water from the concrete if not thoroughly wetted; in fact the parts of the floor where the blocks occur and where they do not, are clearly marked during the earlier stages of the setting of the concrete by the difference in its color, the concrete which does not come in contact with the plaster requiring more time to set.

For moderate spans, the use of concrete joists with either the plaster block or tile filler are desirable, where a flat ceiling is sought and the load light.

The spans over the rooms each side of the corridor are approximately 20 feet long, and are essentially of the same detail as the floor panels between the large girders of the Turngemeinde club house, except that the concrete joists are 4x12 inch, reinforced with $\frac{1}{2}$ inch square twisted bar.

This floor proved to be as economical as any type that might be devised for the purpose, and gave, in addition, a flat ceiling.

The power house is about 1,000 feet from the plant and consists of three engines of 1,000 horsepower each, Cross compound condensing and direct connected to Westinghouse generators, the boilers being equipped with automatic stokers. From this generating set the entire plant is electrically driven.

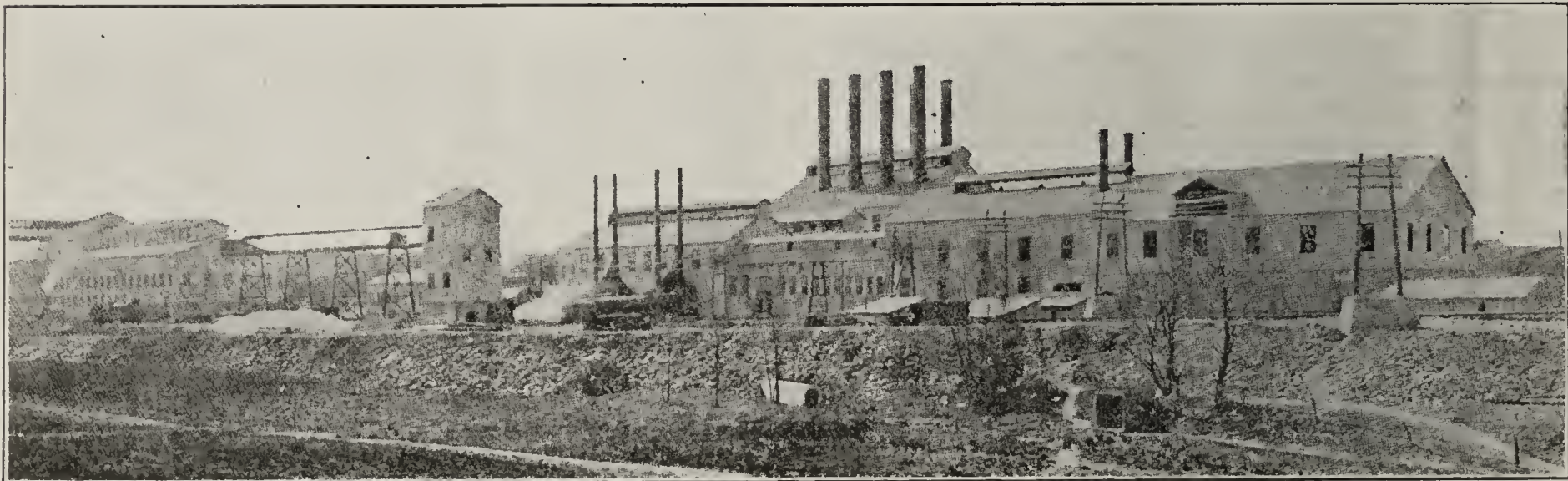
The cement rock as it comes from the quarry is crushed with a No. 10 $\frac{1}{2}$ McCully, which is followed by three No. 6 $\frac{1}{2}$ Lehigh crushers. The raw material grinding room is equipped with Krupp Ball mills and Fuller-Lehigh pulverizers.

The kiln building has four 8 feet by 120 feet kilns, which are fired by the Matcham natural draft system, and the dryers obtain their fuel from the waste gases of these kilns.

The clinker or finished grinding room is equipped with Krupp Ball mills for reducing the Fuller-Lehigh pulverizers and finishers. A large storage capacity for clinker is arranged so that upwards of 50,000 barrels of clinker can be taken care of at one grinding.

The cement stock house has a capacity of 100,000 barrels, and the packing department is equipped with Bates valve packing machines. Throughout the plant great care has been taken for large storage capacity in each department, so that at no time can the plant be stopped for lack of material. The plant has been arranged to increase the capacity up to 5,000 barrels per day without interrupting the present production of 2,500 barrels per day.

The mill has been located beside a rich and inex-



New Plant of the Allentown Portland Cement Company.

THE ALLENTOWN PORTLAND CEMENT COMPANY'S NEW MILL COMBINES MANY MODERN IDEAS.

"Matcham Brand" is the name of the cement which is being manufactured at the newest mill in the Eastern district, and, as the name implies, it is the Allentown Portland Cement Company's, of which Charles A. Matcham is the general manager.

As most of our readers know, Mr. Matcham has designed and built a number of the best cement mills both East and West, and this, his most recent effort, he says is better than any of the rest.

The mill is located at Evansville, Berks county, Pennsylvania, the main office and sales department being located at Allentown, in the Allentown National Bank building. The entire mill has been constructed under the personal supervision of Mr. Matcham and by the Fuller Engineering Company.

P. B. Beery, well and favorably known in the cement trade, is sales manager of the "Matcham" brand, which itself commands a favorable introduction.

haustible deposit of lime rock and cement rock, which is quarried and brought to the mill on a very economical basis, as cement plants go.

The buildings of the plant are constructed entirely of steel frames and concrete. Nearly 20,000 barrels of cement were used in its construction.

The mill was opened on May 1, 1910, and has already earned for itself a place in the trade, as its projectors, and operators are well and favorably known in the cement field both by users, dealers and others.

ZELNICKER'S BULLETIN.

Walter A. Zelnicker Supply Company in St. Louis are now sending out their latest bulletin No. 116 which should be in the hands of all of our readers. It contains a complete list of new and second-hand equipment and supplies which the company are offering at very low prices such as concrete mixers, steel piling, pumps, flat cars, steel rails, manila rope, air compressors, locomotives, cableways, dump cars, steam shovels, rock crushers, road rollers, boilers, etc., etc. Send for one.

A SHORT CUT IN EXCAVATING; HOW A CONTRACTOR REDUCES TIME, LABOR AND COSTS.

By G. P. Blackiston.

A very novel and economical method of handling earth excavation was recently employed at Cumberland, Maryland, by one of the youngest contractors of the town. The topography of the land at the base of operation necessitated the solving of some very perplexing problems of transportation—the solution of which had previously prevented the working of this particular deposit. Briefly, the immense bank of special earth was practically encircled by a deep canyon with the exception of a very narrow stretch of land connecting the mainland, as it were, with the high bank.

The margin of profit being small, ordinary methods of transportation were out of the question. The length and narrowness of the stretch of connecting land did not permit the use of wagons or carts while the use of steam shovels at the working end was quite out of the question due to the impracticability of transporting the shovel to the bank. The use of dump cars operated upon portable tracks was also impracticable unless they could be loaded with the minimum of labor. This, therefore, meant that the material could not be transported at any distance in shovels from the bank to the cars; in short, that the cars must be placed at the very feet of the laborers shoveling—permitting them to transfer the earth—directly from the bed to the car—yet there was no room for a vast complicated system of switches.



How a Contractor Reduces Time, Labor and Costs.

With all this to contend with, the contractor laid a portable railroad across the narrow strip of ground to the bank. Here by means of several short spurs, he placed his cars abreast at the distance of about 10 feet apart. This permitted the laborers to load the respective cars from three sides and without moving a step to secure the load. As the work progressed another section of the portable track (attached to steel ties) was laid and the next cars loaded at a position closer to the base of supply. The cars when loaded were conveyed by gravity to the unloader on the opposite side of the ravine, some 625 ft. away.

By this method coupled with the use of Koppel all steel dump cars and portable tracks made by the Orenstein-Arthur Koppel Co., Pittsburgh, Pa., the material was loaded, conveyed and dumped for less than 6.3 cts. per cu. yd.

NOTES ON CONCRETE CONSTRUCTION.

By Robert A. Cummings*

Someone has said that there is no parallel in industrial progress equal to that of the rapid development of the cement industry throughout the world. Engineers and technical authorities have scrutinized the subject from every angle resulting in its acceptance as a structural material.

Numerous tests have been conducted and theoretical deductions formulated for use in designing structures. While some are tentative, the straight line formulae for beams have been almost universally adopted. Yet, Engineers in general have largely neglected to prepare their designs to meet the practical conditions facing the constructor. It is to this point that I now invite your attention.

For construction purposes, concrete may be classified as plain, reinforced and structural. The application of plain concrete is frequently limited to gravity walls, piers, foundations, dams and similar bulk or mass work; whereas the term "reinforced concrete" has been applied to structures where any kind of metal reinforcement is imbedded. The expression has been used indiscriminately. It has been made to cover plain concrete used for fire-proofing or protection, etc. I believe that the expression does not sufficiently indicate the nature of concrete when applied to articulated structures. Therefore eight or nine years ago during the discussion of a suitable name for the new material, I adopted and have since used the term "structural concrete." It is more definite and descriptive of its use. The term has since been adopted by at least one regularly published periodical. In the use of structural concrete, the metal should be distributed in small

sections so that every pound is utilized in strengthening the concrete in compression as well as in tension.

The interdependent relation between construction and design is as important in structural concrete as in any other department of engineering. One can readily understand the crudeness of all our first efforts in any direction. But the amateur is very much in evidence in the field of structural concrete and seems thoroughly entrenched. Yet there is a great latitude for individual variation and judgment in the design and use of this material. An engineer has been described as "A man who can accomplish with one dollar that which any one can do with two dollars." Now my earnest hope is that we may avoid the reversal

*Consulting Engineer, Pittsburg. Read before the Engineering Society of Western Pennsylvania.

of this description. But, if we are to accomplish the best results, we must judiciously balance the composite parts of our problem. We cannot do this skillfully without sufficient knowledge properly to interpret the available data and the limitations of formulae. This is not all. Practical experience or knowledge as a constructor is equally necessary. If the economics of the materials as shown by our calculations are to be attained, it is just as important that they be combined with the practical conditions governing construction. These cannot fully, nor properly, be interpreted without intimate knowledge and experience in the methods of the field and a liberal endowment of that discriminating part of human nature frequently described as common sense.

An engineer would not venture to design an engine or a steel bridge without shop experience or full knowledge of the practical limitations in construction, so that it may be said with the same emphasis that his work in structural concrete should be governed by similar information. Absence of this requisite is partly accountable for the variations met.

The present age is noted for the quantity of books produced rather than the quality of the literature. This is particularly true of technical publications relating to concrete. For the most part they are made up of compilations or repeated data variously expressed by authors without practical experience. Further, these books have been a prolific source of confusion to the inexperienced practitioner. Consequently, he has become an easy victim to the shrewd salesman presenting the "talking points" of a variety of wings, knobs, twists, etc., given to the steel rods in order to find a market for them.

Only comparatively small structures are built truly monolithic because of the limitations of the amount of concrete that can be placed continuously. Yet the ordinary concrete building is considered monolithic on account of the intimate connection between successive day's work. Local or municipal regulations usually apply to monolithic work and govern the height of buildings and the permissible stresses to be used for materials, yet frequently fail to mention methods of execution or results to be secured.

The economical advantages of continuity in monolithic beams and slabs is dependent upon construction methods. The design should be governed by the amount of concrete that can be placed in a given work-period, or suitable provision be made for bonding the construction mechanically by steel rods embedded in the concrete made during both working-periods.

The shrinkage of monolithic concrete has caused much necessary as well as much unnecessary anxiety. Shrinkage is largely attributable to the cement, but the amount of cement in the mixture and methods used in mixing and subsequent exposure have much influence. Shrinkage may be resisted by embedded metal rods. I well remember an experience of eight years ago when testing some concrete beams 1:2½:5 gravel concrete 10 by 18 in. by 16 ft. long reinforced in the bottom only. Some of these beams showed cracks near the center of the top side the next morning after being made. The extreme ends had raised from the sill of the form as much as one-quarter of an inch. The cracks may be explained by the shrinkage of the concrete at the top of the beam while setting, thus raising of the ends of the beams, until the stress due to the weight of the raised part of the beam was in excess of the tensile strength of its concrete when the beams cracked at the weakest point.

Just as construction methods are related to design so they can be modified to suit the particular type of structure. Hence the unit concrete member has been made independently and erected in position much in the same manner as structural steel is erected. A reason is not

quite clear why this method has not come into more general use, except perhaps, that it is neither patentable nor salable, so it has been let alone to demonstrate its own merit in due time. In its present development on account of numerous joints it should be limited to one-story buildings, such as round-houses, car barns, factories, etc.

The method is capable of combining most of the economics of design and construction. A great advantage is that the concrete is made and deposited in moulds at the ground level where men work more efficiently than from a high scaffold. The cost of forms is a minimum as less lumber is required because the forms are used more frequently with greater salvage. Again, the steel can be placed accurately with ease and at small cost, particularly when made at the shop in fabricated units, tagged and shipped to the work ready for placing in the molds. The cost of such steel is reduced to the minimum for placing. The design is also improved by eliminating uncertain assumptions used for continuity in girders and slabs. All members being simply supported.

Against these advantages one must offset the difficulty of joining the unit members together over columns. The old concrete of the beams does not readily unite with new concrete, so that special provision is required at the joints to unite the members into a rigid structure.

For the purpose of comparison, reinforcement is a phase of the subject which I approach with some trepidation, not only because I have long been identified with a particular method, but do not wish to have my remarks misapplied. Mention has been made of the possible variation in the disposition of steel in the concrete by different designers in their laudable attempt to secure the most economical results. This has led up to a few individual developments characterized as "systems." There has been much abuse of the word "system" in applying it to a variety of roughened rods. Yet there still survive by intrinsic merit certain features of the earlier methods. In a general way these methods may be divided into two classes—"loose rod methods" and "fabricated unit methods."

"Loose rod methods" may be summarized as consisting of a great variety of plain or deformed rods used and placed individually. This method is by far the most generally employed and most popular with contractors. I regret to say it is even so with some engineers, possibly because it is believed that the cost of the steel reinforcement is represented by the raw material.

The question of securing accurate placing of the reinforcement is a matter of small concern to the average contractor, for in his mind his contract is fulfilled by the mere embedment of the specific tonnage of steel rods in the concrete. Where? That is the business of the engineer, is his off-hand answer. The contractor will use the cheapest material he can obtain under the plans and specifications. You cannot blame him for taking a business advantage of the loopholes conveniently provided in the contract, when he has had to meet the stress of the competition of inexperienced or conscienceless bidders and owners. Besides, if loose rod systems are the accepted practice of specialist constructors, why should he not use similar methods? The lowest price is invariably the controlling factor in securing contracts and he can estimate the cost as closely as any one from indefinite or loose rod plans and specifications.

If the loose rod practice of the present time is here fairly represented, it behooves us to stop and reflect a moment and to ask ourselves whether or not a change for the better can be made. For instance, let us more fully consider the question of misplaced reinforcement. I have been told by the engineer having charge of the fire and loading tests conducted by the bureau of build-

ings of a large eastern city, that, of all tests made of the different concrete systems during the past few years, in 90 per cent of them the reinforcement was misplaced. That is, when wrecking the building the rods were found in different positions from those shown by the plans for the test structure. These test houses cannot be called every-day examples of work; they were carefully built for a special purpose to pass a special test. If, therefore, the reinforcement is misplaced under such conditions, what may we expect from work done under ordinary contracts. If the testimony of my twelve years of practical experience is of any value, I would say that reinforcement cannot be held in position except by a mechanical fastening for each rod, or by using the rods fabricated into a system of units made ready for placing and held in position in the concrete. The units should be sufficiently heavy to avoid any tendency to float, due to displacement in the semi-liquid mass. I do not feel called upon to show examples of the difficulties mentioned. They can be easily found by any one who desires such demonstration. But is the point important enough for our serious attention? Except for necessary covering to protect the steel, the only criterion may be said to be the strength of the beam, yet the strength is not seriously affected by a horizontal or lateral misplacement of the individual rods, if the rods are straight from end to end. But, should the hydrostatic action of the semi-liquid concrete or the depositing, puddling and ramming raise the rods, which is the usual case, a very much less bending strength will result. A slight vertical raising of the rods on short spans might cause a reduction of 50 per cent in the bending strength of the beams. This is a matter of vital consequence to the strength of any structure and commands our notice.

There is another contributory point in this matter of misplacement of the reinforcement and this can best be illustrated by an example from practice. My firm was recently invited to submit a proposal for an eight-story concrete building about 100 ft. by 100 ft., according to detail plans and specifications prepared by a western firm of architects and engineers. The reinforcement was designed upon the "loose rod" method. The beam and girder steel being bent up at the third points of the span and the shear steel disposed as vertical loose stirrups carefully shown on the drawings at small horizontal distances apart varying by fractions of an inch. This building was of common type and dimensions and required approximately 142 tons of steel reinforcement. According to the plans there were over 18,000 loose stirrups, every one of which must be accurately placed by an ordinary laborer, and not only that, they must remain in position during the operation of the depositing of the plastic concrete. In addition to these stirrups there were over 25,000 other loose rods for which no guarantee had been provided for positioning, except the generous disposition of the contractor. It seems to me that the lack of restraint and the freedom from exacting work in the manufacture of the concrete and the placing of the reinforcement as at present in vogue accounts as much as anything else for its popularity. It is certain that grave results would have followed its abuse were it not for the one intrinsic merit, that, as designed, structures are frequently stronger than anticipated.

I cannot leave the subject of reinforcement without referring to the distribution of the steel in the concrete. Let us assume that our personal preferences are in favor of certain strength formulae, the symbols of which we are most familiar with. The result of our calculations show say, three square inches of steel required for tension in the center of the beam. Eliminating the uncertainty of bond stress by providing mechanical anchorage at the ends of the rods, shall we use one, three or four,

or how many rods? The answer is not to be found by formulae; but, in the combination of experience and the lowest unit cost of materials.

The much discussed merits of deformed vs. plain rods may be summarized by the question: What is the best shape that will give the area of steel with the greatest bearing perimeter and permit a maximum amount of concrete to surround each rod within the fixed limits of an economical size of beam? An angular cross-section of rod will give less satisfactory results than a round one. Because, a square twisted rod will occupy a space in a beam equal to the diagonal of the square, and this is nearly one and one-half times the diameter of a round rod. All deformed rods of the same nominal diameter and area occupy a greater cross-sectional space than round rods.

In the case of 1 in. and larger square twisted rods that have to be heated in order to be bent, there is an objection to their use because the annealing, due to the heating at the bend, reduces the high elastic limit which is the only advantage gained from use of this particular form of rod. This fact is usually lost sight of and the practical result in a structure in which this form of reinforcement is used that a tension factor has been employed in the calculations of the reinforcement which is greater than is actually secured at all points in those rods which are bent hot. In such cases where the negative bending moments occur at the bent portions of the rods, the discrepancy between the actual and the calculated strength is a matter worthy of serious consideration.

It might be well to bear in mind certain commercial conditions that are met with. Rods as received from the mill may vary 5 per cent or more from the nominal size. In fact, my experience indicates the necessity of strenuous protest, as I have rarely found rods delivered in the exact manner ordered, and this is particularly true of the exact number, size and length required. The disposition of the mill is to ship the tonnage ordered. The accuracy of the shipment depends upon the counting by some mill laborer. This is a formidable objection to loose rod methods as used in the field. It might result in the substitution of sizes of those on hand for those that are required. Besides in loose rod methods a large number of rods are invariably left over on completion of the job. Frequently enough to pay for the differences in cost between a shop-made reinforcement and the loose rods. The actual labor cost of placing loose rods in parts of the structure to be described later, was over six times greater than the cost of placing the rods in fabricated units. Again, one rarely receives the exact lengths ordered, as there are thousands of rods to shear to various lengths and this is done by cheap mill labor. Further, rods are handled by grappling devices in the mill while more or less hot, so that kinks are left in them and they are shipped in this manner to the job. Unless straightened at the shop these bends constitute objectionable features in the reinforcement.

In connection with the placing of reinforcement and holding it in position, the most frequent cause of misplacement is due to the bending up or curving of single rods as they then become in unstable equilibrium and will fall over on one side in order to reach a state of stable equilibrium. Such rods are loose stirrups, turned up, or hooked, slab and beam rods.

There is another practical point for consideration. That is, the general use of "floating rods." These rods may be described as "gentlemen of leisure"; that is, they are without visible means of support. The uncertainty of their final location makes them of questionable value.

My firm recently estimated on a concrete structure, plans for which called for long span beams. The detailed drawings gave evidence of thorough preparation.

Two $\frac{1}{2}$ -in. rods were shown along the top of the beam to be placed exactly 3 inches from the outer surface to the center of the rods. These rods were 50 feet long without support or attachment! The deflection of rods due to their own weight requires that their unsupported length be limited, in order to secure stiffness and a reasonable degree of immovability while the concrete is being placed. These are some of the objections to be mentioned in connection with loose rods. They can be largely avoided by using fabricated shop-made reinforcement.

I can perhaps better illustrate such fabricated unit methods by reference to my own practice during the past few years. To be adapted to all the conditions that are likely to arise in practical work, such methods must comply with the theoretical essentials of design and meet the demand of practical constructors. They must be flexible enough to meet the preference for any shape of plain or deformed rod, and the reinforcement must be rigidly held in position from the molds while the concrete is being deposited. Each rod must be separated from its neighbor and completely embedded in concrete. The rod must be so disposed that the full benefit of the steel may be utilized for tensional stresses. Whether deformed or otherwise the rods should be mechanically anchored at their ends in the concrete in compression to make certain that there will be no slipping of the reinforcement and the full strength of steel may be developed.

I believe that my looped truss girder complies with these conditions and has the practical merit of being a complete self-contained unit for each beam. It is shipped flat, so as to not become bent and to occupy a small space in transit. It may be described as consisting of rods shaped into rectangular frames and arranged in two rows. The upper row consisting of small tension rods that are curved up for the desired length at suitable points to form the shear members, the loops are thus anchored into the compression part of the concrete beam. The upper row is separated from the lower row by a small bar driven tight through holes in flat band staples, the end of this bar being bent down the correct distance to support the steel from the forms.

My hooped columns have in addition to the necessary vertical steel, individual steel hoops attached to a vertical spacing member at uniform distances. These hoops may consist of flat or round steel. The flat steel hoops give about 5 per cent greater core area for same weight of steel. The whole reinforcement is held rigidly together and forms a cage-like unit. Published tests have shown this form of hooping to be very efficient.

Mention may also be made of my chair lock. This is used in connection with units for slab reinforcement. In the slab units the tension rods are formed into rectangular frames which are spaced side by side and fastened to the shrinkage cross rods by the chair lock. This chair lock also securely positions the rods by supporting them from the forms. It is easily placed by simply pinching the top with a pair of heavy pliers.

Under the stress of present day competition, it is not surprising that engineers have found difficulty in having their requirements for concrete complied with. But occasionally plans and specifications may conflict with the practical conditions and economics of construction. Further, it is not universally understood that the cost of concrete structures is largely dependent upon the relation of design to methods of construction. Yet I have observed that the difference in prices named by bidders may be directly attributed to vague, indefinite and uncertain clauses, or omissions, in specifications. Obviously, where an essential is clearly detailed, there can be but little chance or variation or misinterpretation, so that other things being equal, the lowest bidder becomes successful. Again, does not the owner profit by competition

between parties estimating from precise and clear information? It follows then that business relations are improved and there is a greater public appreciation of technical efficiency.

Perhaps there is no essential more frequently omitted from the specifications than the required strength value for the manufactured concrete. Specifications are usually elaborated in great detail, covering physical and chemical properties of the cement, aggregates, proportioning, and preparation of the concrete. Would it not be desirable to insist upon securing a given strength value for the concrete within reasonable limits and leave the manufacture to an experienced contractor?

In the design of the beams, the size is much affected by the assumption for strength value. The strength for a given size beam may be almost doubled by the extremes of the assumptions now in use. Of course, in the latter case there must be an increase in the quality of steel to balance the increase in unit compressive stress used for the concrete. On the one hand, by the use of a very low unit stress in the concrete, we may get a beam, the dead weight of which is out of all proportion to the duty it has to perform. It is very desirable, therefore, that we keep our unit stresses of concrete at such fixed values that an economical size beam will be produced. Then, again, it is not desirable to fix the unit stress in the concrete without reference to the use of the structural member. For instance, in T beams and slabs a higher unit stress is permissible than in simple supported beams. The safe unit stress in hooped concrete columns may be a thousand pounds per square inch, whereas plain concrete is used as low as three hundred pounds.

While it has been shown that the strength of concrete increases with the amount of cement, it must not be forgotten that the difficulties with shrinkage are also increased.

The practice of making structural concrete so fluid that it may be conveyed through pipes by gravity is reprehensible in the light of present knowledge of the loss of strength, separation of aggregates and escape of cement with surplus water, although the cost of depositing the concrete may be diminished by such methods.

On account of the extensive scope of the subject I have omitted any reference to the development of metal forms for concrete members; and to the necessary organization for carrying out economical methods of construction.

EFFECT OF SEWAGE GASES ON CONCRETE WORK.

By Wm. Dunn.

The subject of the present communication, the author stated, was one in regard to which it might be assumed that the available evidence was either inconclusive or of a more or less negative character. For, notwithstanding that cases were on record of destructive changes in tanks and sewers, the opinion tended to prevail that when concrete construction was sound no marked disintegration need be anticipated, neither from sewage nor from its emanations.

The authors experience, however, did not support this view, and it was to the elaboration of this, the positive side of the question, that he desired to direct attention. During the last five or six years he had had very special opportunities for studying the problem.

The concrete was composed of one part of Portland

cement properly mixed with clean water and six parts of ballast thoroughly free from loam, clay, mud, or dirt of any kind, and no material was allowed to be used larger than would pass through a 2-inch screen.

Along the sewage inlet channel it was observed that the greatest disintegration had taken place on the walls at the liquid level. Owing to variations in the flow of the sewage, the level of the liquid in the tank and channel rose and fell; thus a certain area of the walls was constantly being immersed in the sewage and then exposed to the air. This area was, consequently, even when not immersed, much wetter than the part of the walls which was always above the level of the liquid. The latter area at this point showed erosion, which, however, had not penetrated so deeply as that at the level of the liquid itself. At the liquid level there was a deep groove in the concrete, and above this the face of the work had bulged out and lost its nature.

The first portion of the hydrolytic tank appeared to have suffered very little. The walls and roof had only the slight sulphur deposit. At the liquid level, which varied less than in the channel, there was a slight erosion. The second part of the tank, i. e., the hydrolysing chambers, was found to have suffered in places to a marked degree. It was observed on breaking through the erosion on the surface that the concrete at the back was moist, soft and gritty. Also, it was noticed that increased dampness constituted an important factor in the destruction of the concrete, for the lower parts of the vertical faces of the beams supporting the roof were more affected than the upper parts. The lower portions of the vertical walls of the tank also were more eroded than the upper. At the liquid level the concrete had been severely attacked, and a deep groove existed in it.

The point indicated by analyses was the conversion of the lime in the cement into sulphate of lime, the sulphur being obtained from the sewage flowing through the tank and channels, as well as from the gases expelled from the sewage, and contained in the air withdrawn from the several parts of the installation.

Suggested Explanation.

Much thought had been given to the explanation of the foregoing observations, and it had been concluded that the effects had arisen from the putridity of the sewage and the oxidation of the putrid products by the air supply. The main erosive effect was at the varying liquid level, and was there dependent upon the amount of sulphuretted hydrogen in solution in the liquid. The gas was comparatively small in amount in the incoming sewage and the liquid in the hydrolytic tank, and increased as the liquid passed through the hydrolising chambers. The results of this were especially well shown in the two channels; the alternate wet and dry area of the upper channel conveying the sewage, from the rising main was less markedly affected, whilst in the lower channel the corresponding area was severely attacked. So with the two parts of the tank; the first part into which the sewage was delivered, and wherein comparatively little putrefaction took place, had not been affected to anything like the extent that the second part or hydrolising chambers had.

When the level of the liquid fell it left the concrete which it previously covered wetted with a liquid containing sulphuretted hydrogen in solution. This wet surface was then exposed to the action of the air supply, which oxidized the sulphuretted hydrogen with the production of sulphur and sulphuric acids; these decomposed the concrete, the lime being converted finally into sulphate of lime. What the exact nature of the intermediate compounds was could not be stated, as none of them had been isolated, but it was probable that

the active agent was sulphurous acid, as it was known that cement was insoluble in sulphuric acid. When the liquid rose again, the decomposed concrete was washed away either wholly or in part, and a fresh surface was exposed to action when the liquid fell again. It was the continuation of this cycle which led to the formation of the grooves at the varying liquid level.

Concrete Above the Liquid Level.

The erosive effects on the concrete above the liquid level were dependent upon the sulphuretted hydrogen evolved from the liquid and mixed with the air supply. Some of this gas was dissolved by the moisture which was present on the walls and roofs, from evaporation and condensation; it was then oxidized by the air, and decomposed the concrete. In this case the decomposed concrete either remained as a coating on the surface, peeled off, or crumbled away.

Effect on Concrete Tubes.

In order to observe the phenomenon on concrete tubes, two 9-inch concrete tubes were selected, which were supplied by the makers of the paving slabs, previously referred to, and were composed also of similar materials in the same proportion. One of the tubes was coated with Dr. Angus Smith's composition (coal tar, pitch, linseed oil, and resin). They were placed side by side in the second part of the tank in such a position that they would be subjected to the rise and fall in the level of the liquid. At low level the tubes were not in contact with the liquid, and at high level the liquid rose to half the diameter.

After the tubes had remained in the tank for eight months they were taken out and examined. The coated tube did not appear to have been affected, other than at the highest liquid level; where a thin line could be observed, and when struck it was found hard and had a good sound. It was noticed that there were two areas on this tube without any coating, due no doubt to its having been placed upon two supports to allow it to dry; these areas were soft on the surface and similar to the uncoated tube. With these exceptions the tube appeared to be in as good a condition as when first placed in the tank. On the other hand, the uncoated tube had a distinct line at the highest liquid level, which was found to be soft, and when tapped with a chisel had a dull sound; the interior of the tube which had been immersed appeared soft and had a dull sound when struck; the portion of the tube above the liquid level was unaffected, and when struck had a clear ring.

The author then referred to other cases of disintegration of concrete by sulphur compounds.

Conclusions.

The deductions to be drawn from the investigations were that the gases in solution in sewage, and those expelled from it, arising from its decomposition, do act injuriously upon Portland cement concrete, notwithstanding the fact that the concrete is constituted of sound and good materials, when the following conditions prevail:

1. A high degree of putrescence of the sewage.
2. A moistened surface, which held or absorbed the putrid gases.
3. The presence of a free air supply.

Further, that in the absence of one or other of the above enumerated factors little danger from erosion need be feared.

The total production of Portland cement in the United States in 1929 was 62,500,000 barrels.

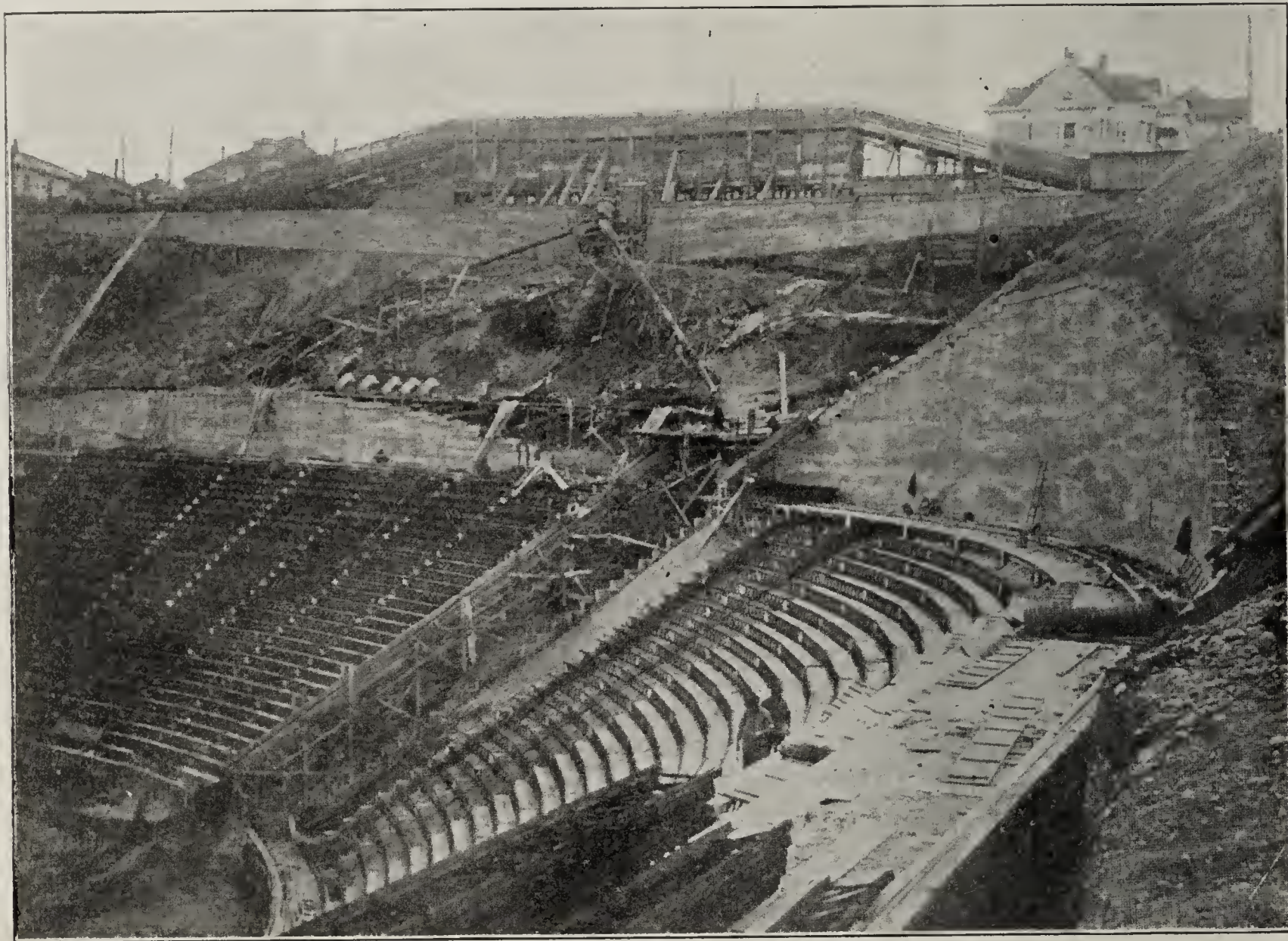
TACOMA'S HIGH SCHOOL STADIUM OF CONCRETE.

Great Athletic Field Where Many Thousands May be Seated
is Constructed With the Modern
Building Material.

On June 10-11, 1910, another monument to the educational and structural development of the Pacific Coast, and particularly to that portion of it known as the Greater Northwest, was formally dedicated by ten thousand of Tacoma's school children. It was the occasion of great rejoicing on the part of the citizens, and the presentation of diamond set gold medals to those who had designed and executed the work. It is the first stadium ever constructed by a municipal school board, and it takes second rank among the stadiums of the

The clearing, grubbing, excavating, grading and piling was done under a contract awarded A. C. Goerig. His principal equipment consisted of a 20-ton shovel and a complement of "Western" dump cars, both furnished by E. P. Jamison & Company through the Tacoma branch. The shovel was fitted with 1 1/4-yard dipper and the cars were 1 1/2-yard capacity. The steam shovel was assisted in the work by two hydraulic jets; the water being furnished free by the city.

Special care was exercised from the beginning that no perishable material such as stumps, roots or logs should remain in any part of the fill or embankment, and later impair the foundations. In finishing the slopes all small roots were clipped close to the surface and the large ones grubbed back two feet. Stones larger than two inches in diameter were removed from the slopes, which were graded 1 to 1 1/2.



Reinforced Concrete Stadium, Tacoma, Wash.

world; the one at Syracuse University being the only larger one in the United States.

Because of its relation to the educational problems of America; because it has been consummated by one of the younger cities of the country, and because it involved some interesting features of construction it will be described here with full credit to those who contributed services and materials.

The tides of Commencement bay, the harbor of Tacoma and an arm of Puget Sound, once rose high beneath the present level of the stadium playground. One of the illustrations, taken after nearly half the fill had been accomplished at a previous time by the city, shows something of the conditions that existed when the work of filling and grading for the stadium was finally started, and also the outlook over the bay from the seats of the present structure. The maximum height of the entire fill is 147 feet, said to be the deepest in the country.

In preparing for the fill the opening of the ravine was cribbed up as shown in the illustrations and a dam built to retain a larger surface area of water into which the cars dumped their contents and sluices carried the wastes from the hydraulic operations. Water would have been used almost entirely for excavating and filling but for the fact that a hard-pan was soon encountered on the sides of the ravine and more vigorous methods were necessary. The function of the pond was to wet and compact all the dirt in the fill, thus securing a soil of sufficient density to carry the loads that were later to be placed upon it.

Piles were employed around the outer edges of the stadium to hold the ground and to support the columns carrying the beams, and in the filled section at the head of the stadium piles were grouped in sets of three and four, according to conditions, and capped with solid concrete. The penetration allowed on the filled-in ground was five inches under the five last blows of a ton hammer

falling 20 feet. At this the maximum penetration was 36 feet. The piles for the job, 480 in all, were seasoned for 30 days, treated with carbolineum and finished not less than 10 inches at the small end and 14 inches at the large.

As concrete was the principal material used in the construction of the stadium, the aggregate and the Portland cement were carefully selected as to sharpness of sand, uniformity and size of gravel, and the setting, soundness and strength of the cement. Moreover, economical ways and means of handling, mixing and distributing the concrete were given special attention by E. A. Conner, of the Western Engineering Company, the firm having the general contract.



View of Western Dump Cars Used in Constructing Stadium. Manufactured by Western Wheeled Scraper Co., Aurora, Ill.

The sand and gravel were furnished by Savage, Schofield & Company, and by the Tacoma Trading company. The 9,000 barrels of Golden Gate Portland cement, manufactured by the Pacific Portland Cement company, were furnished through the Tacoma house of F. T. Crowe & Company. These materials were delivered by teams at the head of the stadium on E. Street, which is 57 feet above the upper promenade and 107 feet above the grade of the arena.

At this point on E street, from which the concrete could be distributed with an equal haul to both the right and left wings of the stadium for columns, beams and seats, bunkers for 200 yards of sand and 400 yards of gravel were built at sufficient height above the street level to permit of batch cars underneath and below the point of bunker discharge. To reach the top of the bunkers, 20 feet above the street, planked inclines were built and the loaded teams were hauled to the top by a cable-way. A Smith mixer, of $\frac{1}{2}$ -yard capacity was installed at the proper level to receive the dry batch conveyed to it by the cars, and close enough to the embankment to send the finished batch by gravity down to the distributing cars.

A double track with turn table was laid beneath the bunkers and out to the Smith mixer. While one car was receiving its correct proportions of sand, gravel and cement (the cement was stored beneath one of the inclines at the end of the tracks and from there was dumped from the sacks into the batch car) the other car was delivering a batch to mixer. Just before entering the mixer the car received from an elevated tank, working on the principle of a water closet, a predetermined amount of water. The concrete was mixed wet enough to flow through the main discharge pipe and down the distributing troughs. By this means of handling the concrete every batch was kept separate and uniform. The cars

used at the bunkers and on the distributing tracks were of the standard mine type with boiler plate boxes of $\frac{1}{2}$ -yard capacity.

A series of the illustrations shows the different stages of handling the concrete from the time it left the Smith mixer until it reached the portable hopper above the seats. It will be noted that a pipe, which was of the ordinary wooden type 12 inches in diameter, conveyed the concrete to the level of the upper promenade where it was received in the distributing cars. The cars operated over the double track shown, along both wings, and dumped into hoppers with a three-way gate. From the hoppers the flow of the concrete was directed by troughs of 8-foot sections to the point of pouring for seats. This system of troughs is shown in another picture.

Pouring for the seats began at the bottom and as the forms filled the section of the trough discharging the concrete was telescoped beneath the section above and pushed up to the desired point. As the pouring proceeded the sections were removed one after the other until the top was reached when the hopper was moved and another system installed. Each system covered forty lineal feet along the total width of the seats, from top to bottom, which represented the area covered in each day's pouring. Including the upper and lower walks, about 4,000 square feet of concrete were poured and finished each day.

Immediately preceeding the concrete work on the seats a crew of men set up the forms. The organization contemplated that the mixer should be the impelling spirit of the entire job. It turned out the mix at regular intervals when cars had to be on hand to take care of it; portable hoppers had to be empty and ready for the cars; and the form makers had to keep ahead of the concreters. The Smith mixer was the pacemaker which accomplished about 150,000 square yards of finished concrete in 38 days. The concrete was mostly laid during April, 1910.



Distributing Concrete to Seat Forms.

The same system of distributing cars was used on the column and beam work. In this, however, the forms laid for the beams served first to convey the concrete down to the forms for the supporting columns—as each one was filled the mixture passed on and down to the next. With the columns poured the concrete was confined to the beam forms. All concrete was mixed 1:2:4. The gravel was limited to sizes ranging from $\frac{1}{4}$ -inch to $\frac{3}{4}$ -inch. For reinforcing the retaining wall high carbon Johnson corrugated steel bars, having an ultimate tensile strength of 95,000 pounds, were used. For all other reinforcement the same make of bar in mild steel with an ultimate tensile strength of 66,000 pounds was used. All bars were carefully cut to length

and bent to follow details, and when spliced were lapped at least two feet. Seventy tons of Johnson bars were used on the job.

Starting from the arena there is a concrete wall rising nine feet high. Within this wall there is a 5-foot walk located 5 feet above the grade of the field. Then follows the seats of which there are 30 tiers. The seats are built with a rise of eighteen inches and a tread of 27 inches. At intervals of 37 feet there are 2-foot aisles, provided with stepping blocks 13x24 inches and a rise of nine inches. At the top there is a 10-foot promenade extending from end to end of the stadium and separated from the seats by 42-inch wall, and from the outside by a 54-inch wall. All aisles open into the upper walk, but none into the arena.

All seats are reinforced with Clinton electrically welded wire, 5x9 mesh, No. 12x12 wire. The upper and lower walks are reinforced with the same fabric, 3x12 mesh, No. 6x10 wire. There was used a total of 130,000 feet of the Clinton product. It was furnished by the L. A. Norris Company, Seattle.

The seats are continuous in construction, are of simple 4-inch slabs, and are supported between beams by latticed steel girders which were designed to carry the live as well as the dead loads. The structural steel for these girders amounted to 160 tons and was supplied by the West Coast Steel Works, Tacoma. The maximum spans were 20 feet, which corresponds to the span of the rises which were virtually concrete beams 3.5 inches thick by 18 inches deep.

The principal concrete beams are 10 inches wide, 34 inches deep and 104 feet long. Their inclination is about 2 in 3. The supporting columns, following as the stadium

does, close to the surface of the excavation, are short excepting at the two ends where the outside ones rise the full height and then follow down the slope of the seats. The exception is necessary to provide space for dressing rooms.

The beam reinforcement consists of five $\frac{3}{4}$ -inch round Johnson rods. Three are continuous at the bottom of the beam, and two are bent upwards near the supporting columns to form a truss. Continuity of steel is secured by looping the bars over a horizontal, transverse pin located above the columns. In addition two short rods run over this pin and a third of the way into the span on each side, following the line of truss rods. At intervals of 8 to 12 inches $\frac{5}{8}$ -inch stirrups are placed.

The columns are octagonal in plan, 18 inches in diameter, and where reinforcement was necessary, four 1-inch Johnson rods were used and tied into a square with No. 6 wire at 8-inch intervals.

The curtain walls around the dressing rooms are six inches thick reinforced with $\frac{3}{4}$ -inch vertical bars at 3-foot intervals, and $\frac{1}{2}$ -inch horizontal rods at 4-foot intervals.

One of the illustrations shows the reinforcement set for one of the retaining walls, of which there were four, varying in length from 160 to 250 feet, and in height from 20 to 30 feet. These walls are of massive construction and required heavy reinforcing of the high carbon steel mentioned above. To protect them from the ground water which is heavy in this climate during the winter and in this location, being in natural drainage area, unusually so, the walls were coated on the back by Toch Brothers' "R. I. W."

Admittance to the stadium is by way of E street where a double and a single stairway are provided. From the

HUNDREDS OF LETTERS PROVE KOPPEL ECONOMY

The following is an extract from a letter on file at our offices from J. H. & M. E. Miller, General Contractors, New Castle, Pa. It is one of hundreds and speaks for itself:

"On the work at New Brighton, Pa., the saving of labor resulting from the use of your equipment was from THIRTY to FORTY per cent. In addition to the advantage in economy of time in the completion of the work, a decidedly better condition of the material delivered was secured by this method."

Very truly yours,

J. H. & M. E. MILLER.

Miller Brothers did this—you can do the same.—Write for further proof and actual transportation cost comparisons.



Orenstein-Arthur Koppel Company

PITTSBURG, PA.

New-York

Boston

Chicago

San Francisco

Baltimore

Philadelphia
Denver

street level to upper promenade there are 91 steps, or a total of 151 to the bottom. The public is protected on the stairways by strong galvanized iron railings at the sides as well as down the center of the double stair. This railing is continued along the stadium side of E street, making in all 6,000 feet of 1½, 2 and 2½-inch pipe.

Twenty-four cast iron combination flag and lamp posts, 24 feet high, 6 inches at the base and 4 inches at the top, are installed around the stadium on the in-wall of the upper promenade. Each of these posts represents one of Tacoma's schools, and on gala occasions carries the flag of its school.

A structure of this kind with its arena exposed to the frequent rains of Puget Sound required special drainage and sewage disposal arrangements. The sub-surface of the arena is a net work of drain tile leading off to mains on each side of the stadium which carry the water in either direction from the head of the grade; about 11,000 lineal feet of drain tile, were used.

By accident the efficiency of the drainage system was demonstrated when a 2½-inch water main burst and flowed for 15 minutes, flooding the arena, and within six minutes after it was stopped the water had disappeared from the surface.

The dressing rooms are 50x60 and 40x50 feet. The larger is for the boys and the smaller for the girls, except on occasion of visiting teams when the girls give up theirs to the guests. These rooms are completely fitted out with everything necessary to modern athletic meets. The comfort stations, one on each side of the stadium at the upper promenade level, are 12x42 feet, and divided for men and women. The plumbing equipment for rooms and stations consists of 24 shower baths, 20 toilets, marble stalls, 10 urinals and 6 wash basins.

The stadium has a seating capacity for 30,000 people. The arena is provided with a cinder track, 5 laps to the mile, and a straight-a-way track 135 yards long. The horse-shoe shaped enclosure is 400 feet wide at the open end and same distance along the central axis. It cost about \$135,000 to build. Most of that amount was raised by popular subscription, and the structure has been turned over to the city free of debt.

MECHANICAL CEMENT UNLOADER AT PANAMA.

A cement unloader, designed by the mechanical engineers of the Commission and constructed at Gorgona shops, was tested on the Cristobal, while that ship was in port during the week of August 1-7. It worked satisfactorily, but a few changes suggested by the working conditions will be made before it is put into regular service.

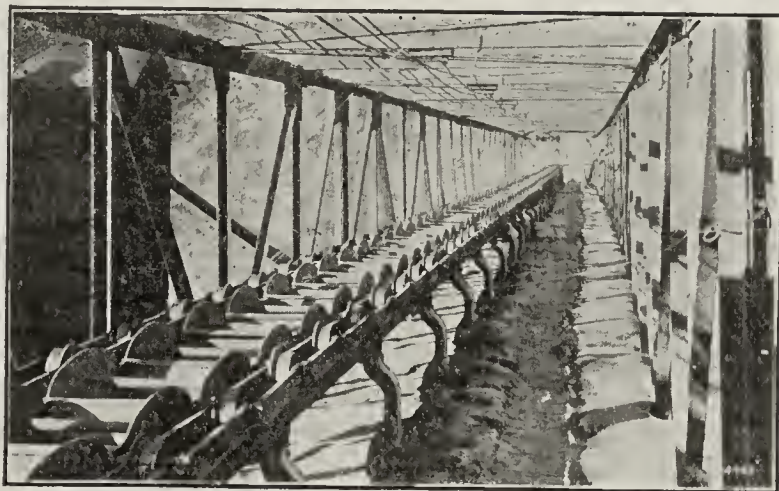
The principle is that of an endless chain which lifts barrels from the hold of the ship and deposits them in the barge tied up alongside the ship. A structural iron truss 45 feet long rests on the deck of the ship with one end overhanging a hatch and the other projecting over the barge. The endless chain or barrel carrier operates through the truss, over sprockets at either end. The carrier consists of two roller chains operating parallel with one another and supporting chain loops so fixed with movable joints to the endless chains that the barrel is held securely from the time it leaves the hold until it is dumped into the barge. From the bottom of the hold to the bottom of the barge a barrel may be carried 125 feet. A motor erected on the truss drives the chain.

PECK CARRIER

fits in with Cement Mill requirements because the wear and tear of this service is confined to a few replaceable wear-resisting parts.

The sprocket wheels and rollers for this work are made of our >FLINT-RIM< iron. Durability at Moderate Cost has been our achievement.

We will send our book No. 81 to any cement man in the country—most have been supplied; but to make sure we would like to hear from anyone who is without a copy.



One of five PECK CARRIERS at the Sandusky Portland Cement Works, Dixon, Ill., to handle clinker, coal and rock.

LINK = BELT COMPANY

PHILADELPHIA

CHICAGO

INDIANAPOLIS

NEW YORK, 299 Broadway

SEATTLE, 439-440 New York Block

PITTSBURGH, 1501-2 Park Building

DENVER, Lindrooth, Shubart & Co.

ST. LOUIS, Central National Bank Bldg.

NEW ORLEANS, Wilmot Mch. Co.

SAN FRANCISCO, Eby Machinery Co.

MR. REICHE GOING ABROAD.

Mr. A. R. Reiche, President of the Orenstein-Arthur Koppel Company, manufacturers of light steel dump cars and portable tracks, with general offices in the Machesney building, leaves Pittsburgh on Sept. 15th for New York whence he sails Saturday on the North German Lloyd steamer, *George Washington* for Germany.

Mr. Reiche expects to be absent in Europe several months. During his absence he will consult with the general officers of the company, who are located in Berlin, with regard to the enlarging of the American plant which is at Koppel, Pa. This town was built by the Koppel company and is situated about 30 miles from this city on the line of the Pittsburgh, Fort Wayne & Chicago Railroad.

The increase in the business has rendered the present plant too small and it will have to be increased to at least double its present capacity in order to meet the demands of the present and provide some room for future growth.

The town of Koppel is a thriving community of over a thousand inhabitants and is dependent upon the steel car works for support. The Koppel company has taken great pride in caring for the comfort of the inhabitants of the town, establishing schools, churches, water works, etc. The town is looking forward to a considerable increase in prosperity with the enlargement of the car works.

In view of the present agitation in the interest of securing more diversified industries in the Pittsburgh district, it is gratifying to learn of those already here being so prosperous. It will tend to induce others to come.

TESTS OF EFFECT OF SALT WATER ON CONCRETE.

Experiments will be undertaken by the Atlantic and Pacific Divisions to determine the effect of sea water on the concrete for the lower locks at Gatun and Miraflores, in order that it may be decided whether it will be advisable to take steps for protecting the concrete. To this end the division engineer of each division has been directed to have made six slabs about three feet square and not less than six inches thick of concrete, the same as that used in the lock masonry, the larger parts of the aggregate to be forked away from one face of the block leaving that face with a finish similar to that of the lock walls. Two of these slabs will be left untreated; two of them will be treated with sodium silicate in the form of soluble glass in solutions of different strength, and two of them will be treated by Sylvester's process with alum and soap, using three-quarters of a pound of soap to one gallon of water applied boiling hot for the first wash, and twenty-four hours later, a solution of alum, two ounces to the gallon, applied cold. One of each pair of slabs will be given a double coat, and the other, two double coats of the respective washes. After they have been treated in this way the slabs, together with those left untreated, will be exposed to the action of salt water at a point as near as possible to the location of the lower guide walls at Gatun and Miraflores. They will be placed in the water simultaneously and allowed to remain immersed until the walls are erected, and it becomes necessary to decide whether or not they are to be treated to resist salt water.

The walls that will be subject to action by salt water will be only those of the lower or sea level locks, and

the guide walls leading into these docks. At Miraflores, about 1,400,000 square feet of surface will be thus exposed, and at Gatun about 1,270,000 square feet.

AN IMPROVED CIRCUIT TESTER FOR BLASTERS.

One of the principal dangers to which those engaged in blasting are exposed, is in encountering unexploded charges of Dynamite in the debris. There has always been a great deal of difficulty in detecting unexploded charges particularly in floor shots, and until recently the blaster has had to depend on his eye to determine whether all of the holes had fired or not. This is at best an unsatisfactory method because in a number of instances, it has been found that the wires and tamping from the hole were not blown out although the dynamite had exploded perfectly. Although the difficulty of locating a missed hole after the blast has been fired still remains, it is now possible for a blaster with care to determine with a great deal of certainty that each of the Electric Fuzes in a blast are in good condition before the shot is fired. A device known as the duPont Galvanometer or a Circuit Tester has been invented and placed on the market which not only indicates whether an electrical circuit is closed or not, but also indicates within practical limits, the amount of electric resistance in the circuit. A blaster may connect the two leading wires to the Galvanometer after the holes are all connected up and the Galvanometer will indicate not only whether the circuit is complete or not, but also if there is leakage through bare connections, etc., the number of Electric Fuzes connected in the series. For instance, if a blaster has 30 holes, in each of which there is an 8-ft. Electric Fuze, by referring to the table furnished with the Galvanometer, he will see that the total amount of resistance is 33-1/2 ohms. If the needle on the Galvanometer now indicates close to that figure, he may be perfectly sure, first; that none of the Electric Fuzes are broken, second; that there is no leakage of current through the bare ends of the connecting wires and third that the leading wires are intact. If a wire of one of the Electric Fuzes has been broken in tamping, the blaster will get no motion of the needle when he connects it to the two leading wires. By going over the bare connections over the holes, it is possible for him in a few minutes to determine which Electric Fuze has the open circuit.

It frequently happens that the leading wires become frayed and the insulation removed in places, and this bare wire may fall over an air or steam pipe or a rail, thereby producing a short circuit through the pipe or rail. When the blaster tests his leading wires on the duPont Galvanometer under these circumstances, it will immediately show a short circuit and the blaster, knowing that the resistance should be calculated from the number of electric fuzes he has connected in series, instantly sees that something is wrong and does not attempt to fire the blast until the wires are lifted clear from the iron.

In locating a break or broken wire in a large floor blast, the instrument can be attached successively to the double lines of bore holes at the ends so that the line containing the break is quickly found, after which the Electric Fuzes in each bore hole are gone over separately. It is, of course, not possible to determine positively after a blast has been fired whether the protruding wires from any bore hole are connected to a live Electric Fuze or not, as the end wires are usually stripped and crumpled together by the blast when it fires, giving an indication of a closed circuit.

LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GROUND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.
ALLENTOWN, PA.

Western Office:
725 ROCKEFELLER BUILDING,
CLEVELAND, OHIO.



Jeffrey "Type B" Pulverizer



is superior in design and construction over other Machines made for reducing Phosphate Rock.

We also build this pulverizer in portable styles for reducing raw limestone for agricultural purposes.

It has a large capacity and yields a more uniformly fine product, consumes less horse power per ton of capacity and costs less for up-keep than any other machine of its kind.

Free crushing tests. Our new catalog Aa31 contains illustrations and full descriptions. Write for copy today.

THE JEFFREY MFG. CO., Columbus, Ohio.

ALPHA PORTLAND CEMENT....

Quality unexcelled The Recognized Standard American Brand Always Uniform

ALPHA PORTLAND CEMENT CO.

Alpha, N. J.
Works: Martins Creek, Pa.
Manheim, W. Va.
Alsens, N. Y.

Manufacturers of but one grade—strictly straight Portland
General Office, EASTON, PA.

Humane Double - Action Trowel

1. Finishes both ways.
2. Does as much work in two hours as a man can do in ten hours the old way, and does it BETTER.
3. Write for prices and literature. Use coupon, postal or letter and address nearest office below.

The Humane Horse Collar Co.

702 Lowe St., Chicago Heights, Ill.

Send me price and all literature on your new
Humane Double-Action Trowel.

Name

Address

Town..... State.....





The Longest, Strongest and Best Stitched
Canvas Belt in the World

In Use Conveying Rock from the Quarry to the Mills of One
of the Largest Cement Plants in the Southwest.

Best on the market
Uniform in construction
You will like it

Applicable always
Limitless in its
Possibilities under
Hardest conditions
A stitched canvas belt

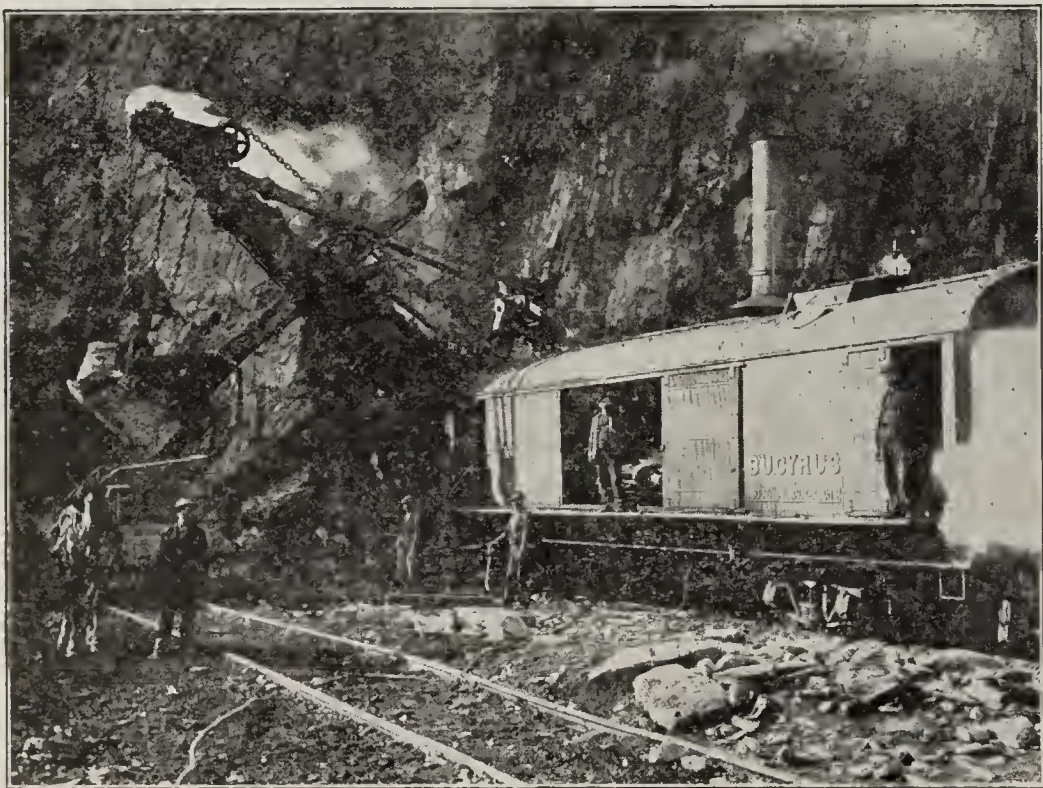
MANUFACTURED BY

The American Belting Co.,
YOUNGSTOWN, OHIO

Chicago Branch: 161 LAKE STREET

Catalogue and Prices Upon Request

AGENTS EVERYWHERE



95-B Bucyrus Steam Shovel in Cement Rock

Steam Shovels

FOR

DIGGING SHALE

AND

CEMENT ROCK

ALSO

STRIPPING QUARRIES

Dredges and General Excavating Machinery

THE BUCYRUS CO.

SOUTH MILWAUKEE, WIS.

The United States Government



operates an official testing laboratory at St. Louis, Mo. At the laboratory it makes beams, columns and blocks, some of plain concrete and others of concrete reinforced in various ways, and tests them, comparing the tests one with another. By this comparison it establishes the relative values of various amounts and forms of reinforcement.

Now to compare the value of one form of reinforcement with another it is plain that, except for the reinforcement, the sample beams or columns must be identical. The concrete mixture must be the same today, next week, a month from now; uniformity absolute and invariable must exist. When, therefore, the director of the laboratory states that "all concrete is mixed in three cube mixers," the statement is significant. The cube, mixing its batch by a kneading process, produces the most uniform and homogeneous concrete of

any type of concrete mixer, THE AUSTIN CUBE MIXER, by its improvement, adds to this property large output and cheap operation. It is therefore the best mixer for the constructing engineer and contractor, as well as for the testing laboratory. Send for catalog No. 5

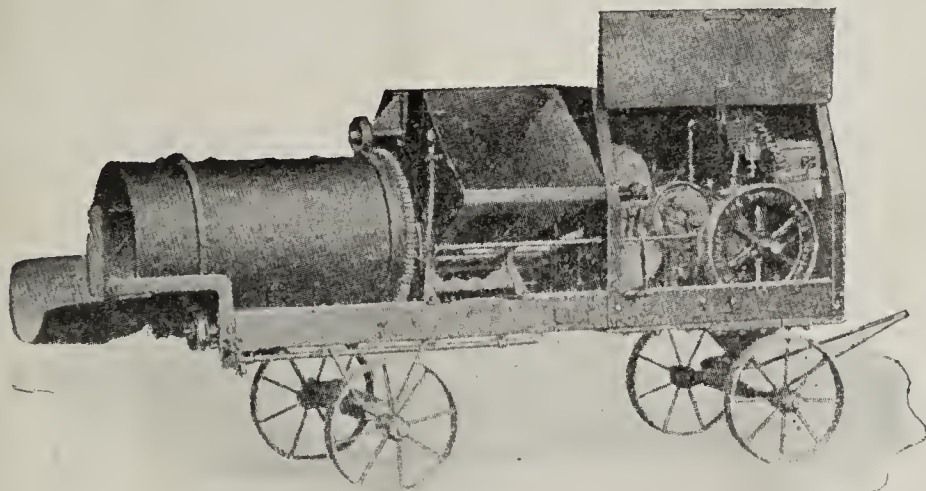
Austin Cube Mixer Company

Agents wanted in unoccupied territory

Railway Exchange, CHICAGO, ILL.

NATIONAL CONCRETE MIXER

**BUILT RIGHT—RUNS RIGHT—PROPORTIONS RIGHT—MIXES RIGHT
THEREFORE IS THE RIGHT ONE FOR YOU TO BUY**



The National does not depend on worms, paddles, spirals, sprockets, or chains to feed, mix, or run, but has an entirely new principle which has proven unbreakable, and that is what counts.

All iron and steel construction.

Has three hoppers located handy to get at. Application of water in plain sight and under perfect control. Will not break, therefore will not break you buying repairs. See the National at Cement Show, booth No. 264, or send for a catalog.

NATIONAL MIXER CO., 408 Powers Building, Rochester, N. Y.

IT WILL PAY YOU TO USE CROWN HYDRATE

(HIGH CALCIUM HYDRATED LIME)

For Waterproofing and Concrete

It Improves Its Strength and Color. Ask the

Marblehead Lime Company

KANSAS CITY

CHICAGO

Do you Know
that

Bates Waterproof Paper Valve Bags

ABSOLUTELY PROTECT CEMENT ?

They Cost no more than the old absorbent Paper Bags

When Ordering Cement Ask for It in

WATERPROOF BAGS

Bates Valve Bag Co.
5100 Lake Ave, CHICAGO.

Urschel Bates Valve Bag Co.
TOLEDO OHIO.

West Jersey Bag Co.
CAMDEN, N. J.

Location for Cement Plant

Extensive Deposits of Raw Material. Proximity to Large and Growing Markets. Low-Priced Fuel Supply.



THERE ARE several desirable locations for Portland Cement Plants along the Santa Fe, where the advantages enumerated are to be found. If you are interested you can secure full and detailed information by addressing this office.

The SANTA FE is glad at all times to co-operate with those seeking locations or desirous of investigating conditions in territory tributary to its line. Correspondence from interested manufacturers is invited.

WESLEY MERRITT, Industrial Commissioner A., T. & S. F. Ry.
1122 Railway Exchange Building CHICAGO, ILL

Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - - 645 No. Sixth St., Terre Haute, Ind.

RAILS! RAILS!! RAILS!!!

New and Second Hand for Track and Building Purposes, cut to any lengths. Delivered to all parts of the United States.

BLOCK POLLAK IRON COMPANY.

Gen'l Offices—First National Bank Bldg., Chicago.

Offices:
Cincinnati, Ohio
St. Louis, Mo.

WE SAVE YOU MONEY.

—STEEL PILING—

NEW and SECOND HAND, Various Lengths

PRICES VERY LOW

WALTER A. ZELNICKER SUPPLY CO.
IN ST. LOUIS

Rail, Equipment and Heavy Machinery Bulletin now Ready

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

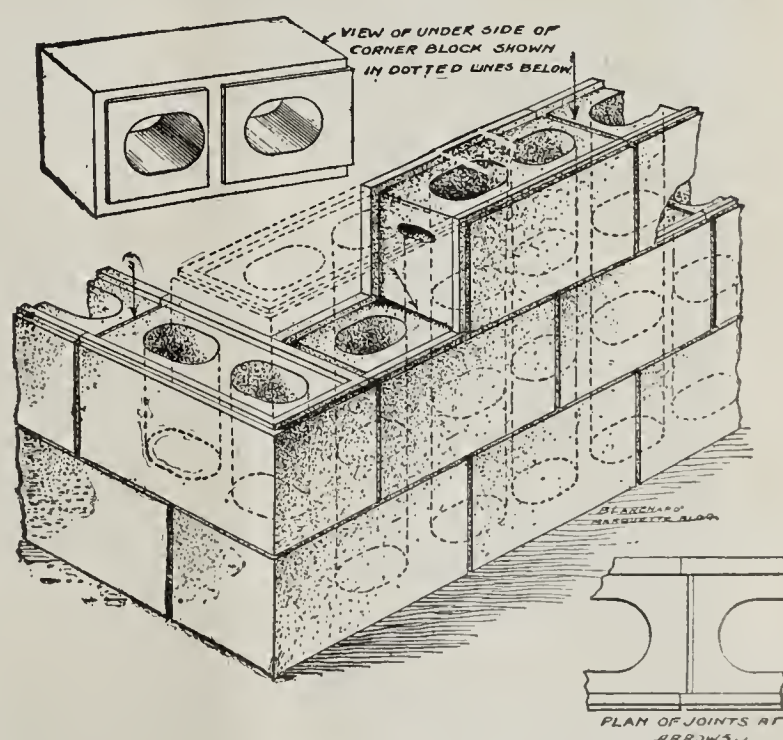
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting Face-Down Machine by the Wet Process

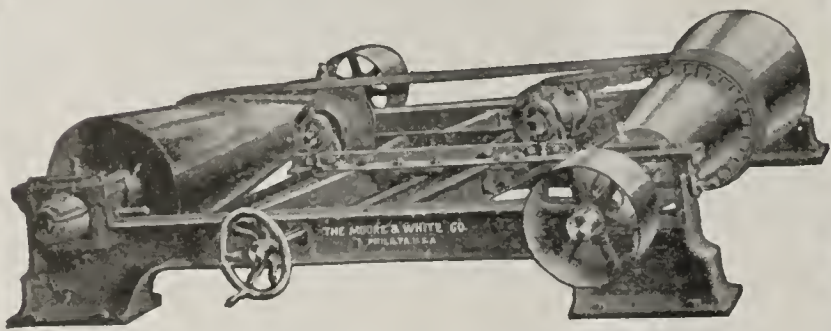
The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and agents wanted in all states and foreign countries.



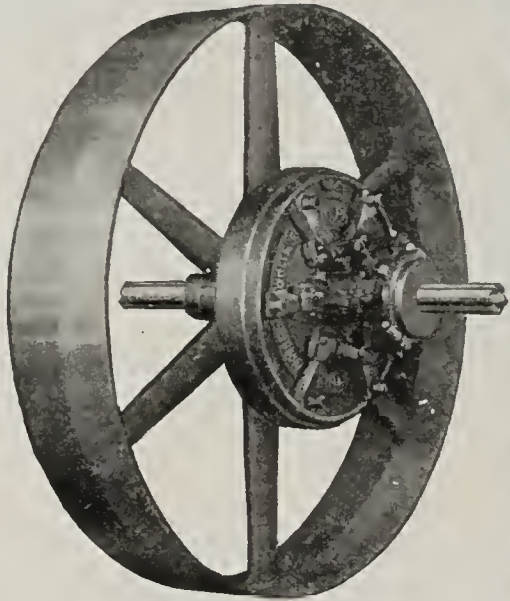
DIAMOND CONCRETE MACHINERY COMPANY
CARDINGTON, OHIO

It will be to any Mill Owner's advantage to investigate these two economical Power devices.



M. & W. Speed Change.

Power
Transmission
Machinery
for
Cement
Mills.



Write for

Catalogue.

Friction Clutch Pulley.

The Moore & White Co.,
Philadelphia, Pa.



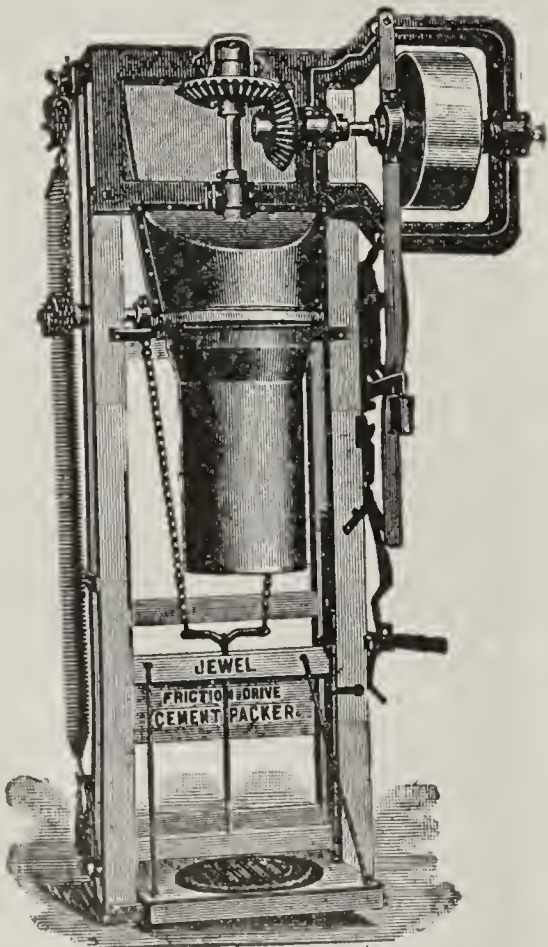
A Big Output
which is constant-
ly increasing cannot be
consistently maintained
unless the cement reaches the
highest standard of excellence.
The remarkable growth in the
production of Universal Port-
land Cement is explained by
the widespread recognition of
its exceptional high quality.

Universal Portland Cement Co.

Chicago—Pittsburg

Annual Output 8,000,000 Barrels

There is more Cement being packed by the "S. HOWES" Company's
Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and
sacks.

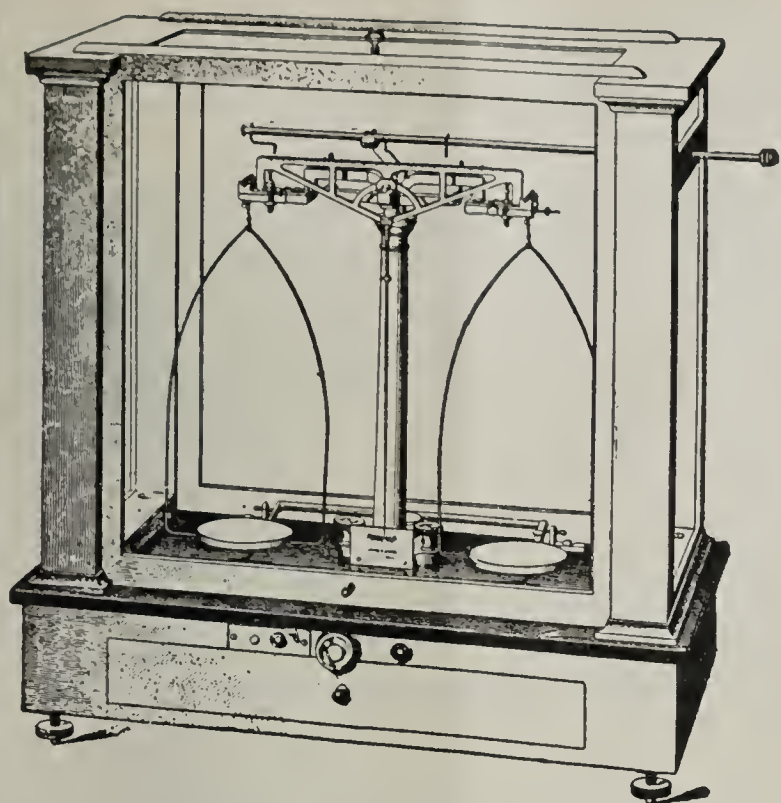
The "JEWEL" FRICTION driven cement Packer, specially
constructed for rapidly packing sacks.

Both machines are equipped with friction pulleys, heavy iron
frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most
durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company
SILVER CREEK, N. Y.



Apparatus for Chemical and Physical Testing of Cement

EIMER & AMEND

205-211 Third Avenue, New York City

MANUFACTURERS OF & HEADQUARTERS FOR

Chemical Apparatus, C. P. Chemicals and Reagents*Cement Briquette Moulds.**Gilmore Needle.**Standard Sieves of Exact Meshes.**Williams' Sp. Gr. Balance.**Specially adapted for determining
Sp. Gr. of Cement.**(Descriptive Pamphlet sent on request)**Schumann's, Le Chatelier's,
Jackson's and Candelot's
Apparatus for Sp. Gr. of
Cement.*Headquarters for **Calorimeters and Pyrometers.***(Our large illustrated Catalogue gladly sent to Chemists on application.)***F. A. Jones, M. E.****Gypsum Specialist**Consulting Mechanical, and Chemical Engineer, in
Designing Construction, and Operation of Plaster Mills,
Mines, and Mixing Plants.Plans, Specifications, Estimates of Cost, Superinten-
dence of Construction, ROTARY or KETTLE PROCESS.Examination, Tests, Analysis, and Reports of Gypsum
Properties, Mills Remodeled and Enlarged, Mixing
Plants Erected, and Formulas Furnished.

883 Mahoning Avenue

YOUNGSTOWN, OHIO**WM. B. SCAIFE & SONS CO.**

221 First Ave., Pittsburg, Pa.

WE-FU-GO*and SCAIFE*

Water Softening, Purifying, and Filtering Systems

— FOR —

BOILER FEED

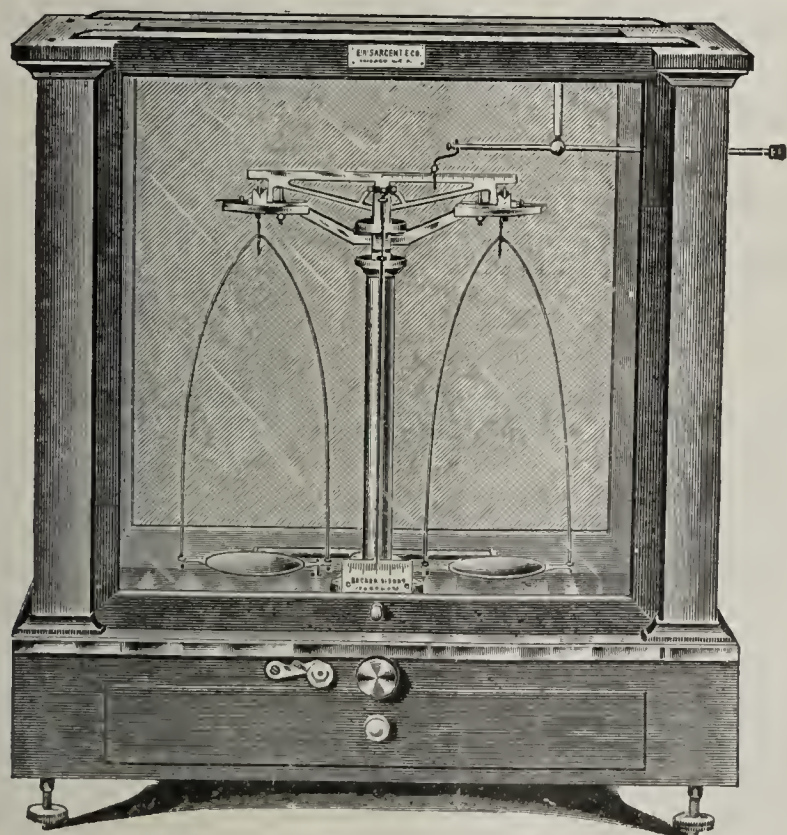
AND EVERY INDUSTRIAL USE.

Send for Complete Information

DEXTER Portland Cement
THE NEW STANDARDSole Agents **SAMUEL H. FRENCH & CO.** Philadelphia**OWL CEMENT**GERMAN AMERICAN
PORTLAND CEMENT WORKS**E. L. COX,**

GENERAL SALES AGENT

1527 Marquette Bldg. CHICAGO, ILL.

**E. H. SARGENT & CO.**

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN

CHEMISTS SUPPLIES

Of high grade only.

We call particular attention to our Cement
Mould, Vicat Indenting Apparatus, as im-
proved by us, Gilmore's Needles, Jackson's
specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

CHICAGO



Medusa White Portland Cement

Used for entire exterior plaster of
Ritz Hotel, San Francisco,
Cal., here illustrated.

A beautiful product adapted to
ornamental artificial stone work
of the highest grade. Equal or
superior to any other White Port-
land Cement known.

Write for free sample, pamphlet
with instructions for use and price.



MEDUSA WATERPROOFING

(Patented Apr. 23, 1907)

Makes concrete impervious to water and prevents ef-
florescence and discoloration. Gives absolutely perma-
nent results and does not affect strength, setting or
color of Portland Cement.

Used by nearly all the foremost Engineers, Architects,
Railways, Contractors, Block Makers and Cement
Experts.

Obtain our price and circular, also price on Medusa
Gray Portland Cement.

SANDUSKY PORTLAND CEMENT Co., Sandusky, O.

"VULCANITE" PORTLAND CEMENT

MAIN OFFICE
Land Title Building
PHILADELPHIA

SALES OFFICE
Flat Iron Building
NEW YORK

PORTLAND CEMENT

WATERPROOFING COMPOUND

Seven Cents per lb. F. O. B. any R. R. Station

We suggest and invite comparison of the unsolicited test reports of cement treated
with our product to those of all others combined.

We Loan Free of Charge a Simple Mixing Machine.

McCORMICK WATERPROOF PORTLAND CEMENT CO.

BANK OF COMMERCE BLDG., ST. LOUIS, MO.

(HIGH CLASS TRAVELING REPRESENTATIVES WANTED.)

The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa

WANT COLUMNS.

Advertisements in this column are inserted at the rate of two dollars per inch per issue—and no advertisement will be taken for less than two dollars and must be paid strictly in advance.

POSITION WANTED.

General Superintendent and Chief Chemist, experienced in wet and dry process. Now operating large dry process mill, are open for engagement. Address Box 35., care Cement & Engineering News.

WANTED.

Two cement burners for plant in the East, 25 cents per hour. Address J. N. K., care Cement & Engineering News, Chicago, Ill.

WANTED.

If you are interested in pumps of latest and best styles, send to us for book and catalogue. Pumps of all styles and for all uses. The Columbus Steam Pump Works, West Broad street, Columbus, Ohio.

WANTED.

An experienced cement burner. Dry process. Kilns 100 x 8 ft. Write us stating experience and wages wanted and how soon can come. Address Rocky Mountains Cement Co, Blairmore, Alberta, Canada.

WANTED.

Position as Supt. of cement mill. Have had 20 years experience in designing, building, and manufacturing in the East and West. Am familiar with every trade and branch of operating, from the quarry to finished cement in cars. Also with coal, and oil as fuel. Address O. H. W., care Cement & Eng. News.

Position wanted by an experienced chemist. Eight years experience in cement and other metallurgical lines. College graduate. Best of references from all employers. Address "Benedict" care Cement & Engineering News.

WANTED.

—in sixty days—a first class experienced chemist. Two experienced burners. A good superintendent. Address Piedmont Portland Cement & Lime Co., Aragon, Ga.

Position wanted by an experienced concrete man as superintendent or manager of a concrete block, pipe or tile plant. Expert in installing steam curing plants for concrete product factories. Can furnish best of references. Eleven years experience. Address P. S. F., care Cement & Engineering News.

Chemist with three years experience in Cement Plant as Chemist and Chief Chemist desires position with Cement Company. Graduate of Mass. Inst. of Tech. Address Chief Chemist., care Cement & Engineering News.

WANTED.

Cement mill repair men for plant in the East, experienced ones only need apply. Must be sober and will-in workers. 25 and 30 cents an hour. Address E. O. C., care Cement & Eng. News.

Iron-Ore Cement

The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in place of Portland cement for all Marine Construction.

Send for Literature, Etc.

WORM-COX COMPANY

SOLE AGENTS

Marquette Building, Chicago

Fire Brick Linings For Cement Kilns

**STANDARD TESTING SAND AND
GENERAL BUILDING SUPPLIES**

**Garden City Sand Co.,
188 Madison St., Chicago**

WANTED.

General Mill Foreman, capable of handling Kent and Fuller Mills. Apply. The Engineering Agency, Inc., 1622 Monadnock Block, Chicago.

TELEGRAPHY.

Learn Wireless and R. R. Telegraphy. Shortage of fully 10,000 Operators on account of 8-hour law and extensive "wireless" developments. We operate under direct supervision of Telegraph Officials and positively place all students, when qualified. Write for catalogue. Nat'l Telegraph Inst., Cincinnati, Philadelphia, Memphis, Davenport, Ia., Columbia, S. C., Portland, Ore.

Peerless Portland Cement

MANUFACTURED AT UNION
CITY, MICH.

Every Barrel Guaranteed

Fineness, Uniformity of Color
and Sand Carrying Qualities
equal to any Portland Cement Manufactured

The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker
1½ inches diameter from the kiln
and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

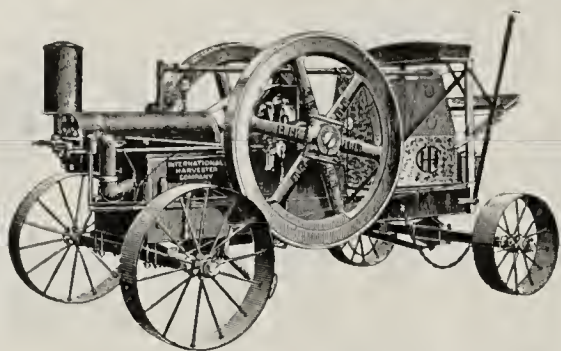
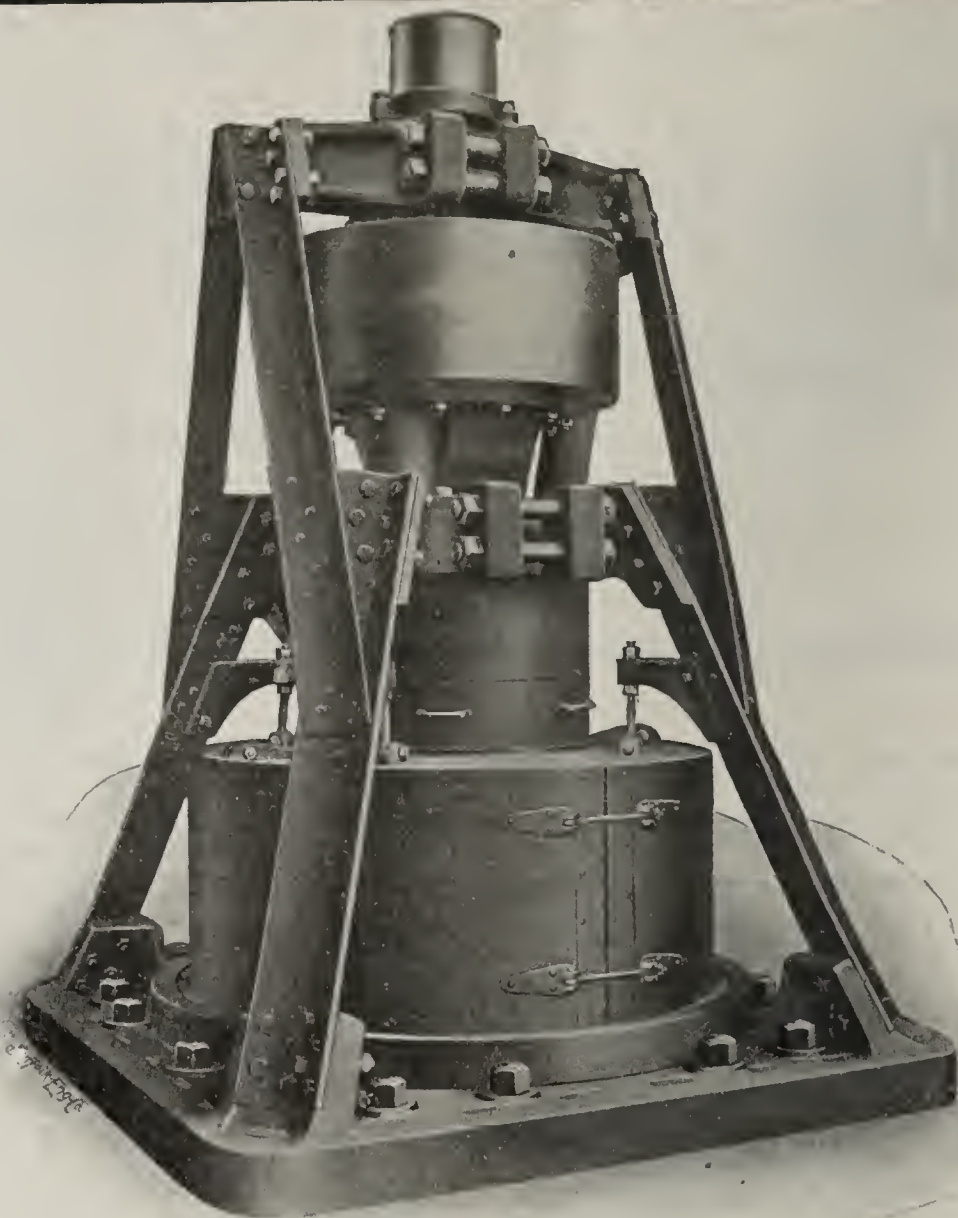
It saves cost in attention.

MANUFACTURED BY

BRADLEY PULVERIZER CO.

37 Walbrook
LONDON, E. C.

92 State Street
BOSTON



I H C GASOLINE ENGINES

Dependable under all Conditions

That is what the concrete worker needs—power he can rely on no matter what the conditions—an engine that will run and run right—winter and summer—in the wet and open as well as housed—that will give good service, anywhere, any time—that will stand up under long hard running or sudden emergency—in short, an I H C.

I H C gasoline engines have proved their reliability through years of hard service in all parts of the world.

Their simplicity and strength make them ideal for concrete mixing and other hard rough work.

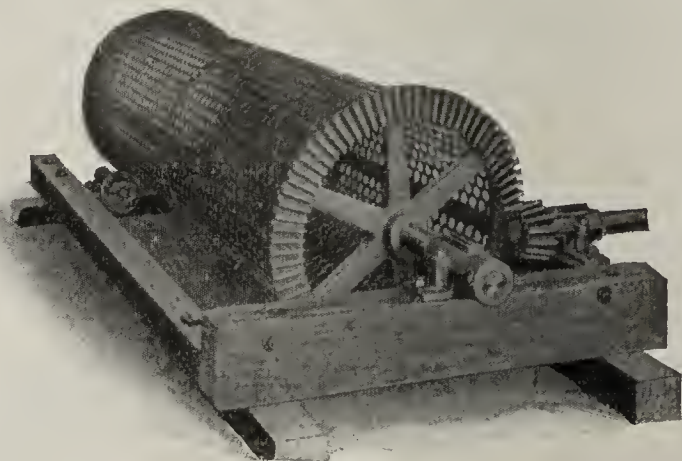
And the same high grade construction that makes them most reliable makes them also most economical.

I H C gasoline engines give most power, on least fuel, with least trouble, and for longest service. They may be had in any size or style—vertical or horizontal—air or water cooled—stationary or portable (skids or trucks)—1 to 25 horse power. They offer just the engine you are looking for. Write us for catalogue and full information.

International Harvester Company of America,
(Incorporated)
41 Harvester Bldg Chicago U S A

WELLER-MADE

Elevating, Conveying and
Power Transmitting Machinery



We furnish a complete line of Screens, Elevators, and Conveyors for Cement Plants, Warehouses, etc.

Efficiency and economy in handling materials is assured by the use of WELLER-MADE Machinery. You are invited to take advantage of our co-operation. Send for 512-page catalog.

WELLER MFG. CO., CHICAGO

THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

Design, Construction, Remodeling and Operation
of Portland Cement Plants

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street
New YorkCanadian Express Bldg.,
Montreal, Can.1121 The Rookery
Chicago425 Washington St.
San Francisco, Cal.Monongahela Bank Bldg.
PittsburghSyndicate Trust Bldg.,
St. Louis, Mo.Norfolk House, Cannon St.
E. C., London

The Osborn Engineering Co. Civil, Mechanical and Electrical Engineers
Experts in the Designing of
CEMENT PLANTS.
OSBORN BUILDING, CLEVELAND, O.
Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement
Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of Cement Machinery

42 NORTH 16TH STREET

:::

PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

Iola, Kansas

Cement Engineers

Just Out!

Architects' and Engineers' Hand Book on
Reinforced Concrete
Construction

ONLY ONE DOLLAR

CEMENT & ENGINEERING NEWS

22 Fifth Avenue, Chicago

COLONIAL TRUST AND SAVINGS BANK

205 La Salle Street, CHICAGO

Capital and Surplus \$1,100,000.00

We are offering High Grade Seasoned 5 to 6% Bonds at attractive prices.

Particulars upon Application



THE IMPROVED DIETRICH'S CLAMP and

Form System for Hollow Walls

By the use of the Improved Dietrichs Clamp and Form System for Hollow Walls the

COST OF CONCRETE CONSTRUCTION IS REDUCED 50%

and the builder also secures a

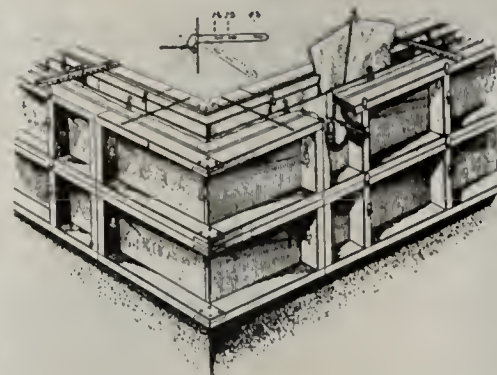
PERFECT DAMP-PROOF WALL

This system is based on the panel principle and employs removable sheet iron inner forms with sheet iron spacer. Corners, doors and window openings are provided for.

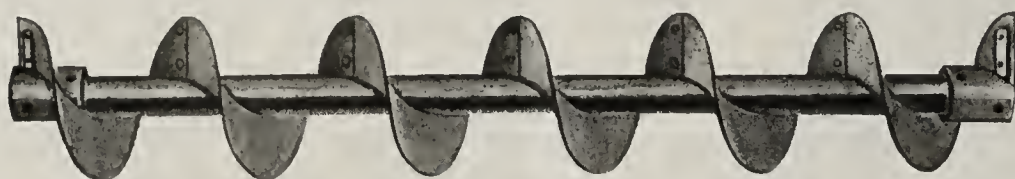
Write for pamphlet giving full information

DIETRICH'S CLAMP CO.

LITTLE FERRY, N. J.



ELEVATING—CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys, Shafting, Shaft Bearings, Link Belting, Special Chains



HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES. Catalog for the asking.

SKILLIN & RICHARDS MFG. CO., CHICAGO

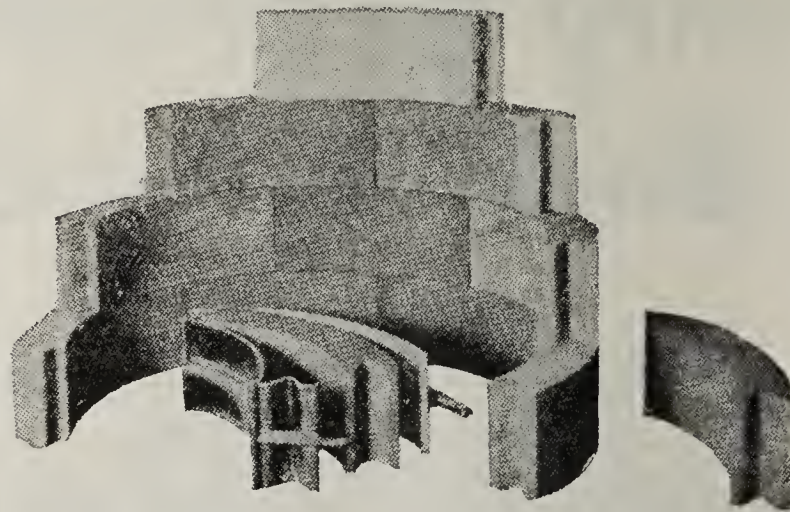
THE PERFECT BRICK MACHINE THE PERFECT CISTERN AND SILO MOLDS

ARE USED IN ALL PARTS OF THE WORLD

OUR MOLDS are the BEST and CHEAPEST ever offered to the public



THE PERFECT is the Simplest, Easiest, Fastest, Most Durable, and is operated with less labor than any other brick machine, therefore yielding more profits to the manufacturer. If you are looking for the latest improved and up-to-date invention you will make no mistake in purchasing the PERFECT.



The Perfect Well, Cistern and Silo Mold.

HERE IS OUR PRICE LIST

No. 3 Circle Mold is 3 ft. diam.	No. 10 Circle Mold is 10 ft. diam.
" 5 " " 5 ft. "	" 12 " " 12 ft. "
" 7 " " 7 ft. "	" 14 " " 14 ft. "
	" 16 " " 16 ft. "

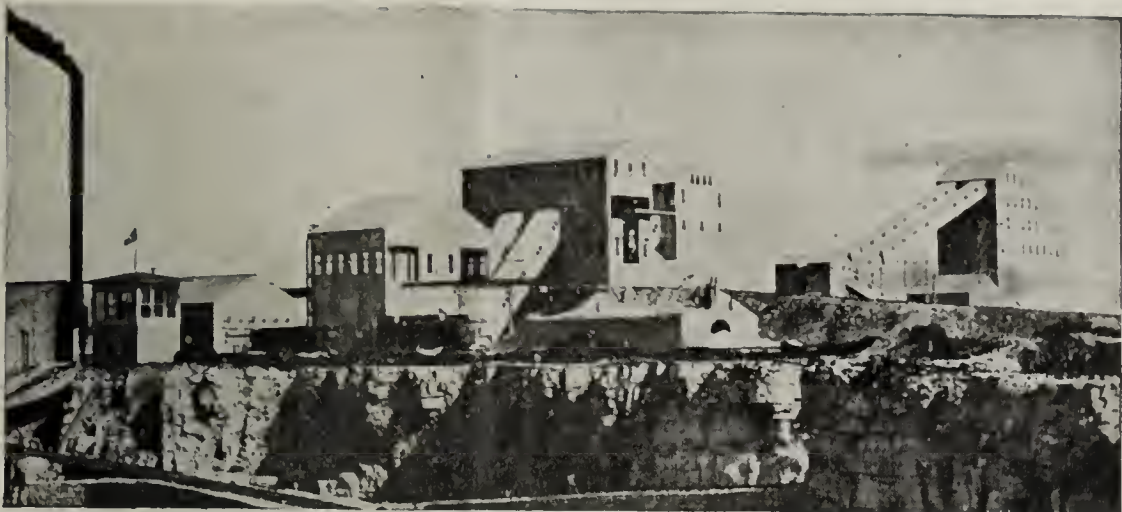
All sizes up to 7 foot retail at \$12.00 each.

All other sizes retail at \$15.00 each.

The Circle Molds vary in length from 22 to 28 inches, depending upon the diameter of its circumference.

In ordering Circle Molds always give the diameter of what you are going to build and I will then understand the kind of a circle mold you desire.

C. S. WERT, 602 North Main Street, Kendallville, Indiana, U.S.A.



Dolese & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world. Machinery throughout installed by us.

OLSON BROS. & CO.

Engineers and Contractors

Cement Mill Machinery Erected, Stone Crushing
Plants Equipped and Erected. :: :: ::

ALSO COMPLETE PLANTS FOR HANDLING
COAL, SAND, GRAVEL, ORES, ASHES, ETC.

MODERN POWER TRANSMISSION
Elevating and Conveying Machinery.

Tanks and Vats, Especially in Connection with Machinery

2418-22 Bloomingdale Ave., Chicago

THE PERFECTION CONCRETE MIXER

A Perfect Feed===A Thorough Mix

"We have three Perfection Concrete Mixers and they do the work in fine shape. I do not know of a mixer on the market that will do the work for the same money."

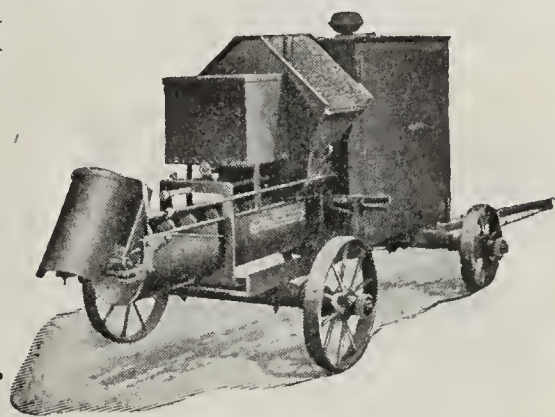
NEWELL CEMENT TILE CO.
Newell, Iowa

We have a 32-page catalog awaiting your request. It is absolutely free, shall we send it?

THE CEMENT TILE MACHINERY COMPANY

RATH STREET

WATERLOO, IOWA



JUST A REMINDER

ATLAS DRYERS—DRY NEARLY EVERYTHING

THE ATLAS DRYER CO., CLEVELAND, OHIO

"COMPETITION"

demand the exercise of the strictest economy in all lines of business. Our ability to take advantage of "Sheriffs," "Receivers" and "Bankrupt" Stocks makes it possible to quote you prices that mean a positive saving of from 30 to 75%. An inquiry will give us a chance to prove our assertions. Write today.

ROCK CRUSHERS.

1—9 x 15 Allis Chalmers Jaw Crusher.

ROCK DRILLS.

6—Ingersoll-Sargeant Rock Drills, size 3 1/4 inches.

6—Ingersoll-Sargeant Rock Drills, size 3 1/2 inches.
Fitted for steam or air.

HOISTING ENGINES.

1—12x16 double cylinder, heavy duty LIDGERWOOD hoisting engine.

1—6x8 Marine Iron Works double cylinder, single drums, reversible in steam chest.

PUMPS.

1—20x13x12 Wheeler & Tappen Duplex Pump.

1—14x8 1/2 x 10 Duplex Laidlaw-Dunn.

1—12x7x12 Duplex Smith Vail.

1—10x6x10 Duplex Dean.

5,000 rolls rubber, leather and canvas belting, structural iron, shafting, pulleys, couplings, steel wire and manilla rope. Smoke stacks, corrugated roofing and siding, hose hydrants, tanks. We can save you money on anything you require.

STANDARD

IRON PIPE.

300,000 ft. 1 1/4 inch
150,000 ft. 1 1/2 inch
250,000 ft. 2 inches
12,000 ft. 10 inches
4,000 ft. 12 inches
30,000 ft. 8 in. Cast
Iron
300 ft. 24 in. Cast
Iron

IRON CASING.

35,000 ft. 1 1/4 inch
40,000 ft. 3/4 inches
60,000 ft. 3/4 inches
8,000 ft. 5/8 inches
9,000 ft. 6/4 inches
1,000 ft. 6 1/2 inches
1,250 ft. 8 1/4 inches

STRUCTURAL STEEL AND IRON.

The most complete line of Structural Steel and Iron in the city, consisting of I-beams, channels, angles, T's, columns, truss rods, joint anchors, girders, sill plates, sidewalk lights, coal-hole covers, new and relaying rails, bridge work, etc. We cut to any size, punch, rivet and fabricate as far as practical, and deliver all

ready to assemble, at a saving to you of 30 to 60 per cent. Send plan of the work you have in view and let us make you an estimate.

TANKS.

12—1,000 gallon capacity tanks.
42—1,500 gallon capacity tanks.
6—3,000 gallon capacity tanks.
15—3,600 gallon capacity tanks.

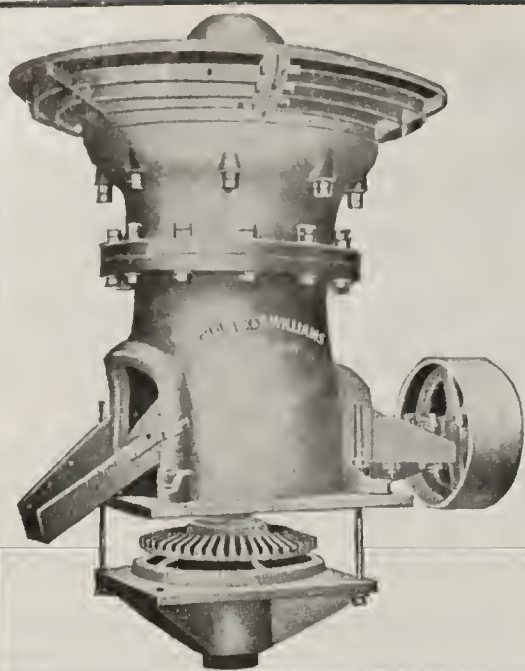
STEEL STORAGE TANKS.

Capacity, 4,500 to 6,500 gallons. These tanks were used only a short time in railroad service. Very heavy construction—1/4" steel with 5-16" heads; domes in proportion to size of tank, and fitted with 15" screwed manhole. We will give them rigid inspection and paint before shipment. Prompt shipment can be made from points South, East and West.

SEND FOR OUR NEW 500-PAGE CATALOG NO. 962.

A wonderful book of facts and information of the utmost value to everyone. Send to-day. It will cost you nothing.

CHICAGO HOUSE WRECKING CO. 35th, and Iron Sts., CHICAGO, ILL.



Kennedy Gyratory Crusher

The only Crusher built with a ball and socket eccentric which will lend itself to any change in the inclination of the main shaft. Improved hopper, more efficient dust collars.

— ALSO —

Cement Making Machinery

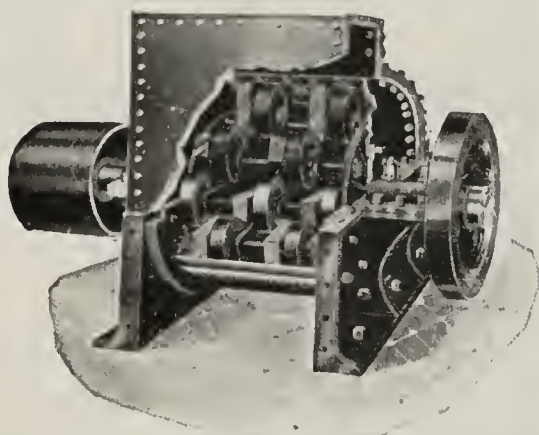
Kilns, Dryers, Tube Mills, Ball Mills, Elevators, Conveyors, Feeders, Revolving Screens and Crushing Rolls.

Chalmers & Williams Inc.

1927 Commercial National Bank Building, - - - Chicago

120 Liberty Street, New York

American Ring-Hammer Pulverizer



Six Sizes.

will pulverize

Cement, Clinker, Shale, Limestone, Coal, Etc.

30 days' working test at your works allowed. Machines guaranteed.

All Grinding Parts Made of MANGANESE STEEL.

Write for particulars and circulars.

AMERICAN PULVERIZER CO.

410 JACCARD BUILDING

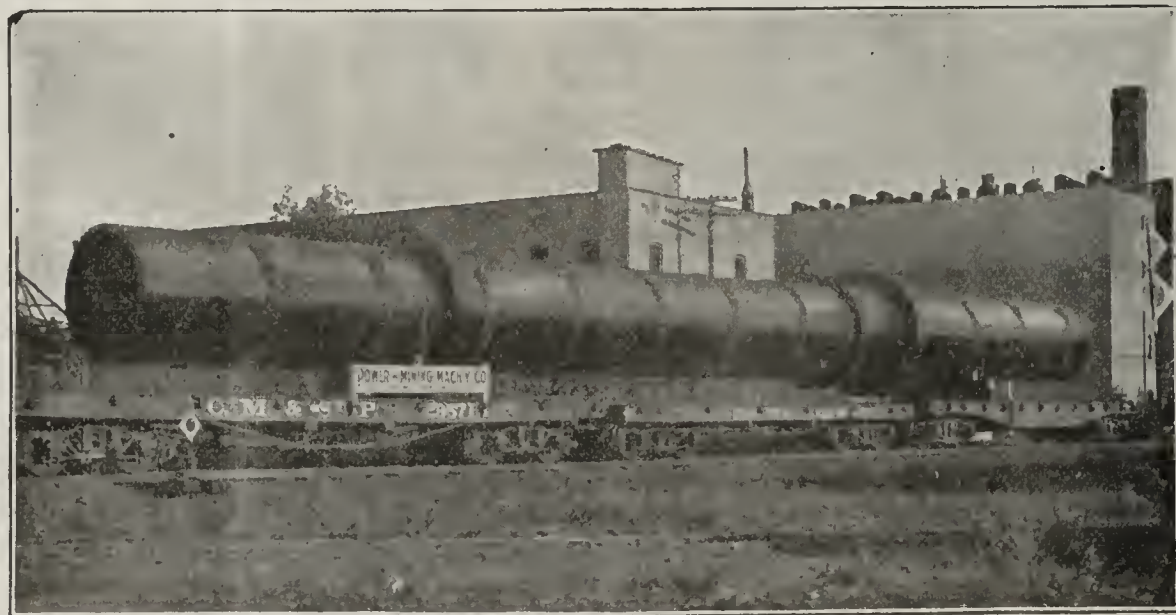


ST. LOUIS, MO.

Cement Mill Machinery

A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process.

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



Write for Catalogue No. 17.

Power & Mining Machinery Company

MILWAUKEE, WIS., U. S. A.

CHICAGO.

NEW YORK.

ATLANTA.

EL PASO.

SAN FRANCISCO.

NEW BOOKS

The Manufacture of Hydraulic Gypsum and Other
Gypsum Products - - - - - 50 Cents

By M. Glasenapp

• The Hardening Process of Hydraulic Cement }
The Hardening of Cement Under Water } - 50 Cents Each
The Constitution of Hydraulic Cements }

By Dr. W. Michaelis, Sr.

How to Use Portland Cement - - - - - 50 Cents

Cement Sidewalk Construction - - - - - 50 Cents

Hollow Concrete Building Block Construction - - - 50 Cents

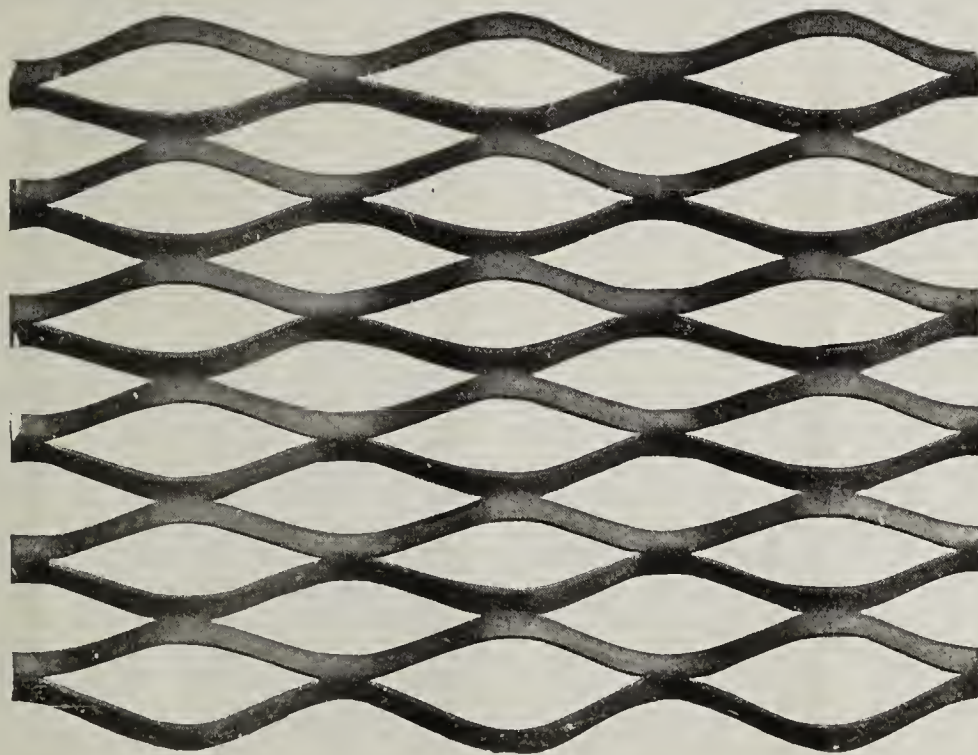
Monier Cement and Steel Construction - - - - - 50 Cents

Handbook of Reinforced Concrete Construction, paper cover 50 Cents

By L. J. Mensch

Delivered Free on Receipt of Price.

Address CEMENT & ENGINEERING NEWS
22 Fifth Avenue, Chicago

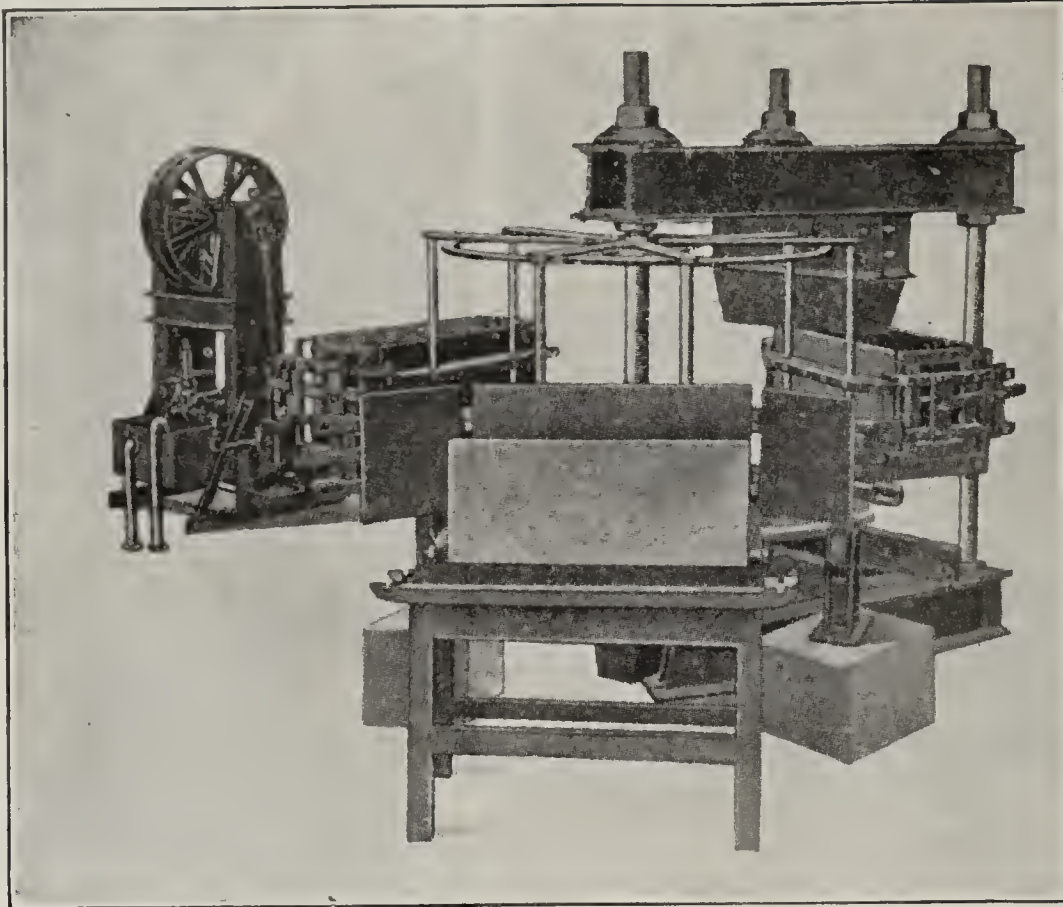


BECAUSE of its peculiar formation and self-furring features ---
"Cleveland" Expanded Metal Lath is especially adapted to
exterior stucco work. ¶ Write Us for Samples and Prices or Further Information

THE GARRY IRON & STEEL COMPANY

NILES, OHIO

A DENSE CONCRETE



A Hydraulic Ram Pounding Concrete Into Blocks

TWO MEN do the work. From 1000 to 2000 blocks per day. Three quick-acting mold boxes rotating over the Ram on a Revolving Table, one being filled, one receiving the pounding, one delivering the finished block.

The Fisher Hydraulic Machine pounds a wet mixed mortar together with a Hydraulic Ram and produces a dense concrete with less than 5% absorption, with a high crushing strength, in any style to suit the demand.

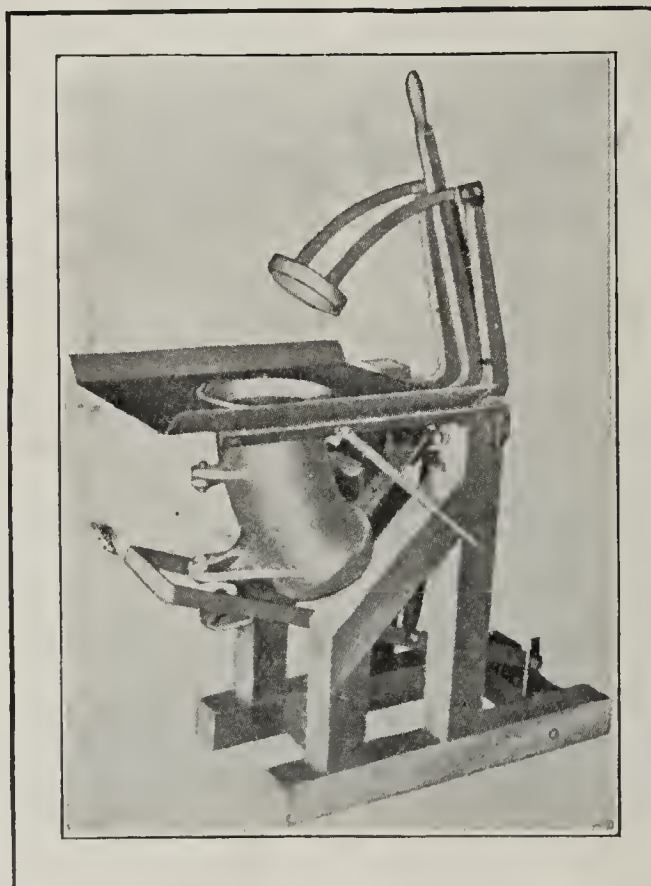
Ask for Catalogue or any information regarding our system.

Fisher Hydraulic Stone & Machinery Co.
MOUNT GILEAD, OHIO.

Concrete Sewer Pipe Bends

**The Only Machine
of Its Kind
on the Market.**

Concrete Sewer Pipe Bends Made on the **RICKMAN SEWER PIPE BEND MACHINE** Make Money for the Manufacturer.



**The Latest Thing
Added to the Concrete
Machinery Line.**

ONE MAN can make from 15 to 20 curved sections of pipe per hour. Shovel in the material, tamp it with the tamping ring, operated by foot lever, attach the bell-end form, complete the section, withdraw core from below, by lever, carry the pipe away to a pallet and bring the outer mold back to the machine.

You Need This Machine to Complete the Equipment of Your Tile Factory

Write for Circulars and Prices

R. L. RICKMAN CO., 987 Westminster Avenue,
VANCOUVER, B. C.

Many years' experience proves the **DIVISION METHOD** (patented) the only Economical, Efficient and Reliable, as well as the most Scientifically and Mechanically Perfect Process for the manufacture of high-grade **SILICA BRICK AND STONE**—the **Twentieth Century Building Material**.

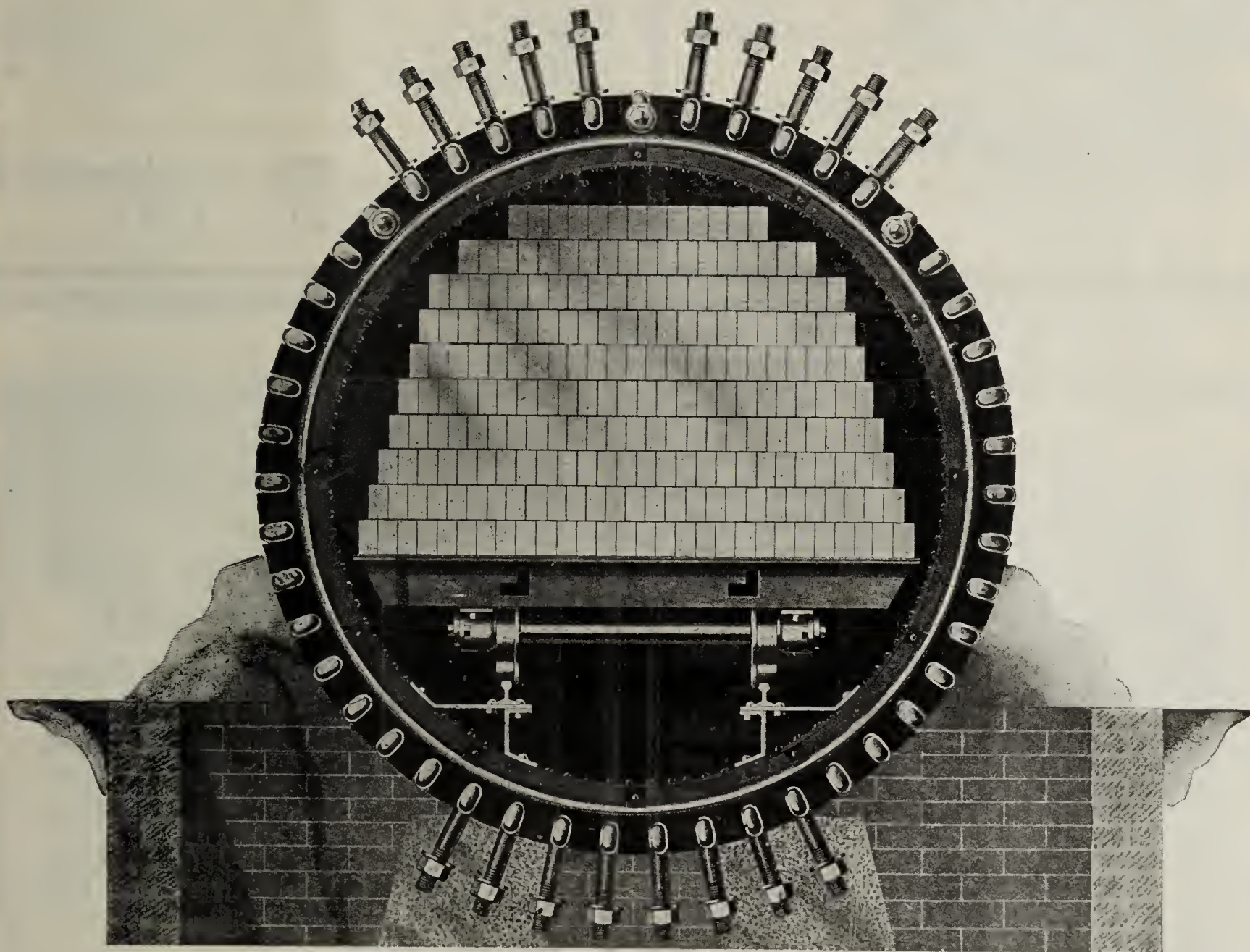
—Let Us Give You Full Information—

International Sand-Lime Brick & Machinery Co.

ENGINEERS AND CONTRACTORS
FOR SILICA BRICK AND STONE FACTORIES

90 WEST STREET, NEW YORK CITY

Sand - Lime Brick Machinery



We build a complete line of Sand-Lime Brick Machinery and appliances. This not only includes Presses, Mixers, Hardening Cylinders and Cars but every machine and appliance needed for the profitable production of highest grade sand-lime brick. Every machine built upon the most approved lines of the best material by competent workmen in our own modern factory. Write for information. We also build a complete line of Clay Working Machinery.

THE AMERICAN CLAY MACHINERY CO.

WILLOUGHBY, OHIO, U. S. A.

SELECTED WHITE SAND

For.

Ornamental
Concrete
Stone



For.

Hard
Plaster
Finishing

Cement
Block

Facing

Exterior
Plastering

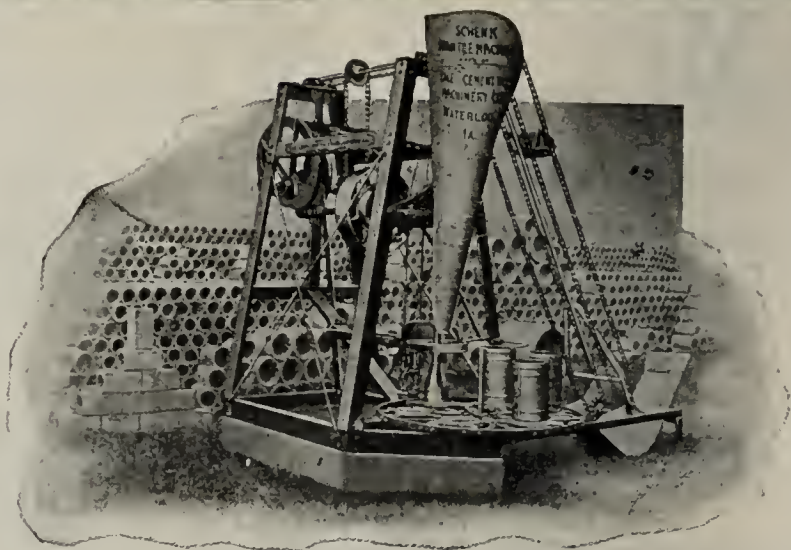
Stone & Marble Sawing

Shipped in paper lined box cars or 150 lb. bags

UNITED STATES SILICA CO.

1041 AMERICAN TRUST BLDG.

CHICAGO



The Schenk Cement Drain Tile Machine

is conceded by all who are familiar with the concrete machinery business to be absolutely the most perfect and the most successful machine in the field; upon its merits the cement drain tile industry has been built; and on account of its success other machines have been constructed, but no machine at the present date surpasses the Schenk Machine for capacity, durability, convenience, economical operation and for satisfaction.

We sell the Schenk on an Iron Clad Guarantee, backed by the largest exclusive concrete machinery manufacturers in the world.

Our free catalog, "Money in Cement Tile" will give you interesting information relative to the proper equipment, the construction of buildings the amount of capital required, the amount of profit to be expected; in fact, it tells how to start a plant for the manufacture of cement drain tile and just what you will be able to realize on your investment.

Write for it today.

The Cement Tile Machinery Co.
WATERLOO, IOWA

WASHED-STEAM DRIED and SCREENED

Ottawa White Sand



Unexcelled for
facing concrete
blocks, orna-
mental concrete
stone, etc.

Analysis 99.88

Prices, Freight
Rates and
Samples on
Application.

You can or-
der less than a
carload, in
fact shipments
as small as
five 175 lb.
bags can be
delivered eco-
nomically.

SEE OUR EXHIBITS

New York Cement Show, Space No. 132. December 14-20, 1910
Chicago Cement Show, Space No. 11. February 17-23, 1911

OFFICES
 BIRMINGHAM
 BOSTON
 BUFFALO
 CHICAGO
 CINCINNATI
 DENVER
 DULUTH
 HAZLETON
 HOUGHTON
 HUNTINGTON
 JOPLIN
 KANSAS CITY
 MEMPHIS
 MEXICO CITY
 NASHVILLE
 NEW ORLEANS
 NEW YORK
 PHILADELPHIA
 PITTSBURGH, PA.
 PORTLAND
 SALT LAKE CITY
 SAN FRANCISCO
 SCRANTON
 SEATTLE
 SHREVEPORT
 SPOKANE
 SPRINGFIELD
 ST. LOUIS
 TERRE HAUTE

THE RED CROSS EXPLOSIVES:

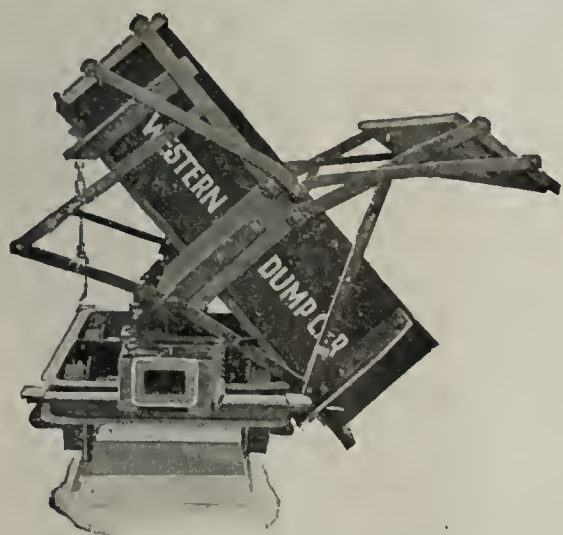
**Red Cross Nitrogly-
cerin Dynamite.**
**Red Cross Ammonia
Dynamite.**
**Red Cross Semi-Gela-
tin. Low freezing,
Slow freezing and
quick Thawing.**

1802
1910

E. I. DU PONT DE NEMOURS POWDER CO., Wilmington, Del. U.S.A.

COPYRIGHTED BY E. I. DU PONT DE NEMOURS POWDER COMPANY, 1910

WESTERN DUMP CARS



1½-yd. Car in Dumped Position

For handling cement, sand, strippings, etc., economically, there is nothing that can compare with the Western Dump Cars. They are made in all sizes from 1¼ yard on 2-ft. gauge, up to the heavy double truck railroad cars on standard gauge.

The low lift for the shovellers, the steep dumping angle, automatic side boards, high quality of material used in their construction, are a few of the many points which make the Western unequalled.

Western Wheeled Scrapers
Western Fresno Scrapers
Western Elevating Graders
Western Dump Carts

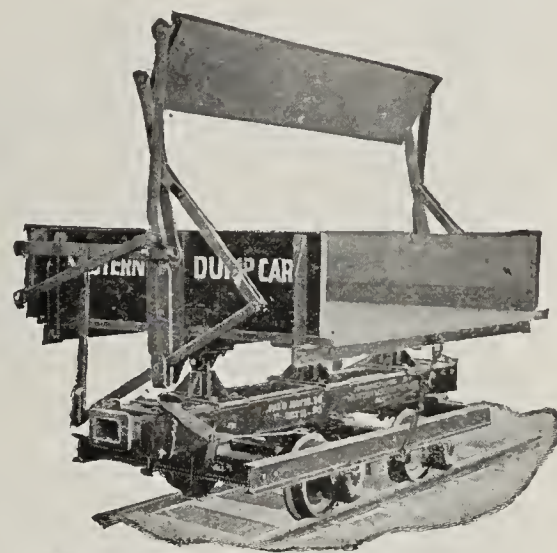
Western Drag Scrapers
Western Railroad Plows
Western Road Graders
Aurora Rock Crushers

Aurora Dump Wagons

Send for Catalog of Earth and Stone Handling Machinery

Western Wheeled Scraper Co.

Aurora, Illinois



1½-yd. Side Dump Car with side board raised ready for loading by hand.



None Just As Good

The book, "REINFORCED CONCRETE IN FACTORY CONSTRUCTION," will be sent for 10c. It illustrates and describes many different types of factories built of concrete. It demonstrates the economy, safety, convenience and adaptability of concrete for all factory purposes.

Other books in the Atlas Cement Library:

Concrete Houses and Cottages Vol. I. Large Houses \$1.00
Vol. II. Small Houses 1.00

Concrete Construction about the Home and on the Farm, Free

Concrete in Highway Construction 1.00

Concrete in Railroad Construction..... 1.00

Concrete Cottages, Free Concrete Garages, Free

If your dealer cannot supply you with Atlas, write to

THE ATLAS PORTLAND CEMENT COMPANY
DEPT. D. 30 BROAD STREET, N. Y.

Largest productive capacity of any cement company in the world. Over 50,000 barrels per day.

Hotel Cumberland

NEW YORK

S.W. Cor. Broadway and 54th St.

Near 50th Street Subway Station and 53d Street Elevated

HEADQUARTERS FOR THE CEMENT
AND MACHINERY MEN.

New Modern Fire Proof

All Outside Rooms. No Carpets. All Oriental Rugs.

Transient Rates \$2.50 with Bath and up.

10 minutes walk to 20 theatres.

Send for Booklet.

HARRY P. SIMPSON, Formerly with Hotel Imperial.

R. J. BINGHAM, Formerly with Hotel Woodward

CHARLES F. MCKENNA, Ph. D.

Inspection of Cement

and all other Engineering Materials. Examination of Properties and of Economical Operation of Works.

Consulting and General Practice in
Chemistry, Technology, Chemical
Engineering and Chemico-
Legal Cases.

Long Distance Telephone.

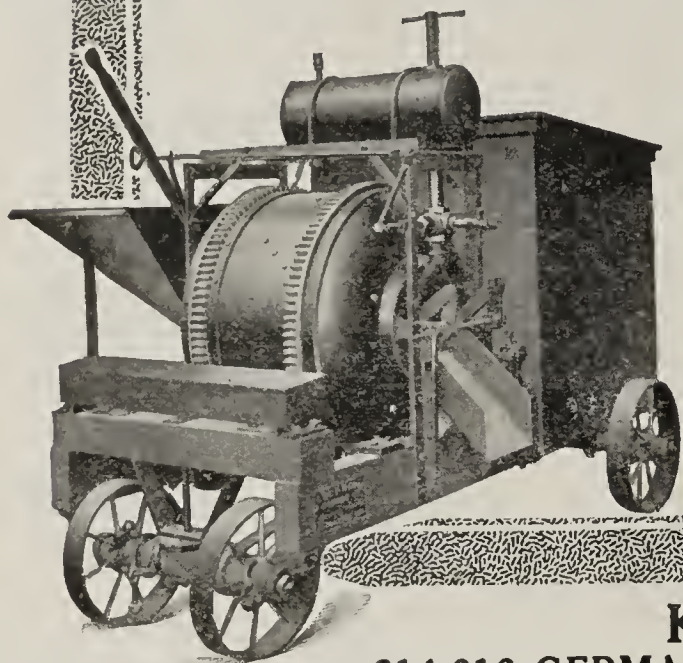
Cable Address: PLAT PEARL

Laboratories: 221 Pearl St., New York City

Offices: 50 Church Street

By Any Standard of Quality The Koehring Concrete Mixer Is Peer

In Quality of Product
—Quantity of Output—
Manual Labor Saved
and Dependableness
of The Machine—
None Other Excels.



THREE independent mixings in the one drum, each performed by a positive mechanical force, with no sharp angles or corners is a guaranty of quality of mixing.

Lifting and pouring from the side, casting alternately from end-to-end, breaking over against heavy cast iron heads of the drum and a constant pouring off the inner end of the discharge chute represents a rapidity of mixing no other equals.

Discharging by merely raising the inner end of the discharge chute and always taking out the exact quantity desired, is manual labor economy you know is the minimum.

The heaviest constructed drum on any mixer, resting on trunnion rollers placed close to the ends, the rollers cast with wide faces, chilled as hard as tempered steel, and a double gear drive with pinions placed high to prevent binding in case the drum settles, comprises a dependableness the greatest mechanical genius will never question.

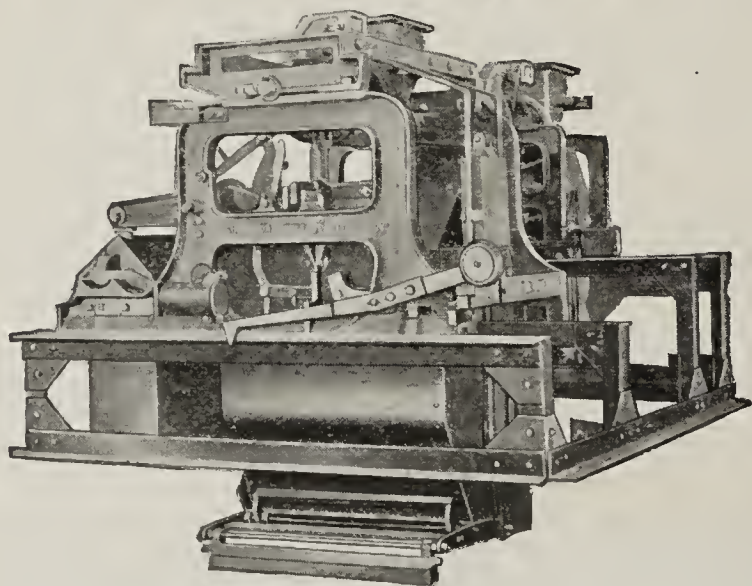
Built in types and sizes for every requirement; equipped with gasoline, steam or electric power.

It's chock full of dollar-saving quality—quality in the concrete and quality in the machine. Ask for "Catalog B."



KOEHRING MACHINE COMPANY
614-616 GERMANIA BUILDING MILWAUKEE, WIS., U. S. A.

TO MAKE THE BEST CEMENT, USE Richardson's Automatic Proportioning Scales



Two or more scales yoked together with our Electric Discharge Mechanism will weigh Crushed Raw Materials direct from bins with perfect accuracy and discharge simultaneously.

These machines fitted with our Conveyor Feed will also weigh Pulverized Materials direct from bins.

Greatest Possible Range of Weights. Exact Proportions Absolutely Guaranteed. Continuous Uninterrupted Operation.

Similar Machines for Clinker and Gypsum. Automatic Hopper Scales for weighing Cement to Stock Bins. Automatic Bagging Scales for Finished Cement. Speedy and most accurate yet devised.

Write for particulars to

RICHARDSON SCALE COMPANY
16 Park Row, NEW YORK 122 Monroe St., CHICAGO

Highest Class Cement Rope Sacks

CEMENT SACKS FURNISHED PLAIN OR PRINTED

Samples and quotations
furnished upon request

CONTINENTAL PAPER BAG CO.

Paper Mill, Bag Factory and Printing Plant

RUMFORD, MAINE

Address inquiries to General Office,

**Whitehall Bldg., 17 Battery Place
NEW YORK CITY**

CEMENT

... AND ...

ENGINEERING NEWS



A reinforced concrete elevated wash-water tank built for the Louisville Water Company's filtration plant. Height over all 80 feet, elevation of tank above ground level 46 feet 2 inches.

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue

Cable Address—“Seaferts” Chicago.

Entered at the Post Office at Chicago, as Second-class matter, July 21, 1896
under Act of March 3d, 1879.

Subscription. \$2.00 Per Year
Foreign Subscription. \$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON

Advertising Manager

Chicago, November 1910.

FINE GRINDING OF CEMENT.

Of the three types of grinding machinery used in the manufacture of cement, outside of the power plant, namely grinding mills, conveying machinery and burning apparatus, the first and the last had to receive special attention on the part of the manufacturer, as the task of producing a reliable cement at a minimum cost involved constant improvements in these departments. As the outcome of these efforts we may consider that we possess grinding machinery of the highest efficiency which it will be difficult to improve, except in details of minor importance. The burning apparatus, however, is still far from being perfect. During fifteen years of experimenting with the rotary kiln, practically nothing has been done beyond lengthening and widening the kiln, and only now serious efforts are being made to transform this wasteful apparatus into a furnace equally economical in fuel as the upright kiln. This will be accomplished by burning the cement with producer gas previously heated to a high temperature in regenerators, a device which promises to become the system of the future. Thus, while the experiments with the rotary kiln are far from being completed, we are able to look back at definite results in the grinding department and, in doing so, find a number of different mills put upon the market at intervals of several years that are as many stepping-stones towards improving the manufactured product and cheapening the cost of production.

The objections to the old-fashioned mill-stone, which was an excellent fine-grinder as long as cement commanded a high price, were the frequent dressing which it required, the high consumption of power and the fact that quartz of the necessary hardness was found only at few places and, therefore, had mostly to be imported.

Ball mill and tube mill did away with some of these disadvantages. They are and always will be the most reliable mills as far as repairs and safety of operation are concerned.

The next type of machine, the Huntington mill, or in its improved form the Griffin mill, had a hard time in the beginning to hold its own against the combination of ball mill and tube mill. The repairs were excessive until the construction of the mill, especially the wearing parts, were improved in time so that it finally became a keen competitor of the tube mill. For about ten years, ball mill and tube mill on the one side and the Griffin mill on the other were considered as equally good. The growing competition, however, soon brought out a decided advantage of the Griffin mill, namely that it produced a larger percentage of flour.

As long as a comparatively coarse cement was accepted by the building trade, the fineness of which was determined only by means of a 100-mesh sieve, both grinding systems were satisfactory. But, since the builder started

to buy cement according to its sand carrying capacity, it proved to be advantageous to use Griffin mills for grinding. The reason for the difference in the products of the two grinding systems was discovered in the fact that the tube mill ground the cement grit fed into it only to a certain fineness and that, beyond this point, the flour prevented the coarser particles from being reduced any further. The pebbles rotating within the mill merely dropped on a soft layer of cement dust without being able to crush the coarser particles imbedded in it, whereas the conditions in the Griffin mill were entirely different, the material being thrown against the die by centrifugal force and being reduced by abrasion against the coarser particles as well as by the weight of the swinging crushing roll.

This drawback of the tube mill was speedily overcome by coupling it with an air-separator, which removed the fine from the coarse and returned the grit to the tube mill for further grinding. The addition of this useful device made the tube mill one of the most efficient fine-grinders; in fact any desired fineness can easily be obtained by this combination.

The aim to further reduce the operating expenses and especially to reduce the consumption of power led to the most modern types of mills, the Maxecon or improved Kent mill and the Fuller-Lehigh mill. Both are now extensively installed in Europe as well as in the United States, the former claiming the record for low horse power and minimum repairs and the latter for fine grinding.

Also the air-separators went through a series of changes, before they reached the present height of perfection, and required a number of years to prove their usefulness. To-day their merits are so well known, that they are installed at most new plants and are frequently added to the grinding machinery of established mills. The improvement in the product obtained through air-separation is so marked that a skilled cement tester can generally tell, if a brand of cement submitted to him has been passed through air-separators. The sand carrying capacity, hence the value of a cement as a mortar, is so much greater than with Portland cements ground without the aid of separators, that unusually high strength of a cement immediately suggests air-separation, and inquiries at the plant as to the grinding machinery employed will reveal in almost every instance that the assumption of the cement tester was correct.

Thus, saving of power and obtaining of the utmost fineness of the finished product were the chief aims in improving the grinding machinery. Both problems may be considered as being solved satisfactorily, as the power consumed by the most modern mills is remarkably low indeed and as further fine grinding would be impractical; the cement would become so quick-setting that no retarding chemicals would restore it to a normal setting time. And yet, the test demonstrated for the first time 40 years ago, that hardened cement reground and gauged with water once more, and subsequently for a third time, still develops considerable strength holds good in these days of fine grinding as well as half a century ago when hardly 50% passed a 100-mesh sieve.

The developments of the last years have shown that only the dust particles of the commercial product constitute the cementing material proper. The grains which merely pass a 200-mesh sieve are entirely too coarse to form a binding mortar when gauged with water. Hence, new methods are being devised by the International Society for Testing Materials for determining the percentage of the flour, the actual cement, so that in the future commercial cements may be compared, not by the residue on the 200-mesh sieve, but by the percentage of impalpable powder determined by elutriation in alcohol or benzene.

THE CALCIUM SILICATES AND CALCIUM ALUMINATES CONTAINED IN PORTLAND CEMENT.

By Dr. O. Schott.

Translated by Dr. W. Michaelis, Jr.

(Continued from page 420)

CALCIUM-SILICATES.

Calcium silicates without water of combination are very rare in nature. Only one mineral of this kind is known, namely wollastonite, the calcium compound of the meta-silicic acid of the composition CaO, SiO_2 . On the other hand, calcium hydro-silicates are more frequent, as for instance plombierite $\text{CaSiO}_3, 2\text{H}_2\text{O}$, okacite $\text{H}_3\text{Ca} (\text{SiO}_3)_2 + \text{H}_2\text{O}$ and apophyllite, which latter contains potassium in addition to calcium. Calcium silicates without water of combination deriving from the ortho-silicic acid do not occur in nature. At the first glance, this seems to disprove the possibility of existence of such compounds; however, it must be borne in mind that, wherever calcium oxide and silica occurred in nature, almost invariably alumina or magnesia were likewise present, so that there was an ample opportunity for the formation of double-compounds of which a large number are known. But it is strange to see that the magnesium, which is closely related to calcium, forms a salt of the ortho-silicic acid, namely olivine $2\text{MgO}, \text{SiO}_2$.

In order to make the existence of a tri-calcium silicate more credible, attention has been called to chondrodite which has been regarded as tri-magnesium silicate, $3\text{MgO}, \text{SiO}_2$. The composition of this mineral, however, is still doubtful. An analysis of chondrodite made by Naumann, showing 33.3% SiO_2 ; 54.3% MgO ; 6.62% FeO ; 6.6% Fe and 1.7% H_2O would indicate rather a di-magnesium silicate.

Thus nature gives us little information about the existence of definite calcium-silica compounds.

Artificially calcium silicates can be prepared in a two-fold manner; in the first place, by the wet process, a method frequently employed during the early period of cement investigation.

While the early experimenters, as for instance Heldt, tried to obtain such compounds by adding a solution of calcium hydrate to sodium water glass, without taking into consideration the formation of a possible double-compound of calcium oxide, sodium oxide and silica, Kanter followed a different way by mixing colloidal silica and solutions of calcium hydrate in different proportions. Thus Kanter was able to contradict the statement made by former investigators who claimed that a di-calcium silicate could be formed by the wet process; he obtained invariably a hydro-silicate $\text{CaO}, \text{SiO}_2, 1.1 \text{H}_2\text{O}$. Calcium-silica compounds higher in calcium oxide can not be obtained by the wet process.

On the other hand, a number of calcium silicates have been obtained by fusion from a mixture of the ingredients in the proper proportions, or in some instances they have been considered to be compounds without proof for the correctness of this assumption.

Mere fusing of mixtures of silica and calcium oxide, which is possible in all proportions, does not indicate that a compound has been formed. We have rather to assume that certain compounds forming in the process of fusing are able to dissolve a certain percentage of calcium oxide. The fused products,

consequently, represent solid solutions or alloys. That calcium oxide and silica can be fused together in any ratio desired and yield homogeneous compounds, as Schmidt assumes, is correct only in as much as the exterior of the fused product suggests a perfectly uniform body. However, the behavior of these fused mixtures of silica and calcium oxide towards water indicates that a certain percentage of calcium oxide must not be exceeded. If this limit is surpassed, which according to my experiments coincides with the composition $2.5 \text{CaO}, 1 \text{SiO}_2$, the powdered product, after being mixed with water, shows the properties characteristic of a 'blowing' cement. This phenomenon, in my opinion, indicates that the fused product does not represent a homogeneous body, but that free uncombined or undissolved lime is present; for the latter causes the expansion, which according to Le Chatelier is an infallible sign of the presence of uncombined lime.

The temperatures required for fusing mixtures of calcium oxide and silica have been underrated frequently heretofore. This is due to the fact that in most instances impure raw materials were used and that no attention was paid to the circumstance that the high-limed mixtures seized every opportunity possible of taking up silica and alumina, which amply offered itself wherever so-called fire-proof or refractory crucibles were used. In order to enable them to do so, it is not even necessary that the mixtures of calcium oxide and silica are fused; such high-limed mixtures take up silica and alumina far below the melting point, absorbing these substances as a sponge absorbs water, and thus reducing the fusing point considerably. An absorption of 2% of alumina, for instance, in accordance with my tests, lowers the fusing point several hundred centigrades. The few analyses of fused or sintered mixtures of calcium oxide and silica which are to be found in the literature on the subject plainly show that such adulterations have been mostly overlooked.

A mixture answering the composition of the di-calcium silicate and all mixtures higher in lime than this fuse only at a temperature beyond the melting point of platinum. This experience was gained by the observation that the formerly described platinum frame, consisting of one-sixteenth inch platinum wire, fused while the cylinder of di-calcium silicate enclosed in it was not even vitrified. Mixtures lower in lime than the di-calcium silicate fuse at a lower temperature; likewise the aluminates and ferrites. It was interesting to observe that a mixture of the composition of the tri-calcium aluminate fused more readily than the di-calcium aluminate and the latter at a lower temperature than the mono-calcium aluminate.

Molecular Proportions.	Raw Materials	Melting Point
$1\text{CaO}, 1\text{SiO}_2$	CaSO_4 and SiO_2	1300 Celsius
$1\text{CaO}, 1\text{SiO}_2$	CaSO_3 and SiO_2	1450 "
$2\text{CaO}, 1\text{SiO}_2$	CaO and SiO_2	about 1900 "
$2.5\text{CaO}, 1\text{SiO}_2$	" " "	above " "
$3\text{CaO}, 1\text{SiO}_2$	" " "	" " "
$1\text{CaO}, 1\text{Al}_2\text{O}_3$	CaCO_3 and Al_2O_3	1500 "
$2\text{CaO}, 1\text{Al}_2\text{O}_3$	" " "	1450 "
$2.5\text{CaO}, 1\text{Al}_2\text{O}_3$	" " "	1450 "
$3\text{CaO}, 1\text{Al}_2\text{O}_3$	" " "	1400 "
$1\text{CaO}, 1\text{Fe}_2\text{O}_3$	CaCO_3 and Fe_2O_3	1450 "
$2\text{CaO}, 1\text{Fe}_2\text{O}_3$	" " "	1500 "
$3\text{CaO}, 1\text{Fe}_2\text{O}_3$	" " "	1530 "
$3\text{CaO}, 1\text{SiO}_2$ plus 4% Al_2O_3	CaO, SiO_2 and Al_2O_3	1600 "

The foregoing table contains the melting points of mixtures determined by me with the aid of the Le Chatelier pyrometer up to 1600 centigrade. For temperatures beyond this point Seger cones were used.

The temperatures above 1600 centigrades were determined with Seger cones of different melting points placed in a circle in the furnace No. 11 and 12 at equal distance from the arc-light as the walls of the calcium oxide-silica cylinders. The cones were subsequently exposed to the radiating heat of the arc-light for the same length of time as the cylinders, whereby the current registered the same number of amperes and volts as required for the fusing of the lime-silica cylinders. In this manner at least a superficial idea can be obtained of the temperature employed.

The following table gives the duration of the current necessary for obtaining, by the radiating heat of the arc-light, in each case a cylinder which was fused inside, but hardly vitrified on the outside.

Molecular Proportions	Ampere	Volt	Time
2CaO, 1SiO ₂	60	135	20 min.
2.5CaO, 1SiO ₂	80	135	25 "
3CaO, 1SiO ₂	80	135	40 "
3CaO, 1SiO ₂ plus 4% Al ₂ O ₃	60	135	15 "
3CaO, 1SiO ₂ plus 7% Al ₂ O ₃	50	135	10 "
3CaO, 1SiO ₂ plus 8.5% Al ₂ O ₃	50	135	5 "

The inside diameter of the cylinders was two inches and the wall was three-sixteenth inch thick.

I did not make use of fluxes, as for instance boracic acid, as this would have changed the physical and chemical properties of the fused products and would have led inaccurate results.

In producing calcium silicates I started with the mono-calcium silicate and afterwards fused mixtures answering in composition the di-calcium silicate and "tri-calcium silicate." As the latter proved to be unsound when gauged with water, I prepared mixtures of calcium oxide and silica between the di-calcium silicate and tri-calcium silicate and endeavored to determine the point at which destruction on account of expansion began. The result was that all mixtures between the composition 2CaO, 1SiO₂ and 2.5CaO, 1SiO₂ showed excellent hydraulic properties and that they hardened the better the higher, the percentage of calcium oxide was between these limits. Blowing began undoubtedly with the composition 2.5CaO, 1SiO₂. This latter mixture showed feeble signs of blowing, which disappeared completely after having been exposed to the air for several days, hence fully resembled slightly over-limed Portland cement in this respect. All mixtures higher in lime, however, were unsound and could not be cured by exposure to the atmosphere.

The Mono-Calcium Silicate. The mono-calcium silicate is the only anhydrous calcium silicate occurring in nature. Le Chatelier and Kanter believed to have produced it also by the wet process; they found the composition to be CaO, SiO₂, 1.1H₂O.

Le Chatelier considered it the only silicate liable to form during the hardening of cement. I obtained the mono-calcium silicate by fusing of equivalent amounts of gypsum and silica in a platinum vessel. In doing so, I assumed that silica, which represents a strong acid at high temperatures, would drive off the sulphuric acid of the gypsum and take its place. For the first experiment I employed a temperature of 1300 centigrade and observed white fumes of anhydrous sulphuric acid, in addition, a slight odor of

sulphurous acid. However, the high temperature alone may have possibly caused the decomposition of the gypsum. For this reason, I had to determine at first the temperature required for decomposing calcium sulphate.

The calcining of pure gypsum revealed that the first white fumes were given off at 1450 centigrade. The gas leaving the furnace was directed through a wash bottle filled with water by which the sulphuric acid fumes were absorbed; thus the point of decomposition could be determined very closely. This experiment showed that the decomposition of calcium sulphate, if caused by calcining alone, began at first at a temperature of 1450 centigrade. Calcium sulphate, calcined for an hour at 1450 centigrade, contained 41.28% CaO and 58.70% SO₃; hence, had lost only 1.2% of its sulphuric acid.

Now, I proceeded again to calcine a mixture of calcium-sulphate and silica in equimolecular proportions. At this time, I burnt for one hour at 1200 centigrade. The material, which was moistened with water and formed into small balls, was vitrified throughout and was fused to the platinum vessel at the points of contact. A determination of the sulphuric acid showed that not even a trace of it was present.

The experiment was repeated and the mixture was burnt, in one instance at 1100 centigrade for two hours and in another at the same temperature for four hours. In the second case, the result was about the same as during the former experiment that is to say, no signs of sulphuric acid could be detected, while in the first case still a small amount of sulphuric acid was precipitated by barium chloride and the contents of the platinum receptacle were found to be vitrified so slightly, that they could be dumped out upon turning the vessel over. In order to make sure whether or not the silica alone was the cause of this decomposition, I prepared a mixture which did not contain calcium sulphate and silica in equimolecular proportions but which contained 10% less silica. This mixture was heated at 1200 centigrade for four hours. It was found to contain large amounts of sulphuric acid. The result was the same after heating of the mixture at 1300 centigrade for two hours; the mixture was fused almost throughout and yet contained a large percentage of sulphuric acid. Thus it was proven that by fusing in equimolecular proportions of calcium sulphate and silica mono-calcium silicate was formed. As this compound was formed even at 1000 centigrade upon prolonged heating, it was of interest to know at what temperature the reaction set in. For this purpose I needed a very sensitive reagent for the determination of the smallest trace of sulphurous acid, as all customary reagents, as for instance silver nitrate, were not appropriate. An excellent solution, by means of which I obtained the desired results was composed of zinc chloride, sodium carbonate and potassium ferro-cyanide to which a few drops of sodium nitro-prusside were added. This solution turned bright red in the presence of the smallest trace of sulphurous acid.

The mixture of calcium sulphate and silica was placed into a platinum crucible covered with a lid having a hole in the center, through which a well-fitting clay pipe was introduced. The other end of this pipe was connected with a glass tube containing the reagent and, beyond the latter, with a suction pump. The temperature was raised 10 degrees at a time, and the first trace of sulphurous acid was observed at 970 centigrade. Repeated tests invariably

gave the same result. Upon raising the temperature gradually to 1100 centigrade, whereby sulphurous acid developed continuously it was found that the development of sulphurous acid decreased after an hour, which could be determined by frequent renewal of the reagent. Upon further increase of the temperature to 1200 centigrade, sulphurous acid was developed again in large quantities; this ceased completely at the end of another hour, when the sintered material was found to be absolutely free of sulphuric acid. In addition to the sulphurous acid, sulphuric acid had been developed right along, which became noticeable through the presence of white fumes.

If heated for a long time at a temperature of 1300 centigrade, the mono-calcium silicate fused down to a transparent glass, which upon being taken out of the furnace, formed an opalescent hardened mass. At temperatures below 1300 centigrade a strongly vitrified product was obtained.

The fused substance adhered firmly to the platinum vessel so that it could be removed only with great effort. Even upon raising of the temperature to 1400 centigrade, the thin molten mass could not be poured out of the platinum vessel, as it solidified upon being taken out of the furnace. A platinum crucible with a hole in the bottom and cone-shaped platinum valve proved also to be unsuccessful, as the molten apparently thin liquid, after being heated to a temperature of 1400 centigrade for half an hour, did not flow out of the relatively small opening.

Subsequently I chilled the contents of the crucible immediately upon taking the crucible out of the furnace by placing it into ice water, a method customary for removing molten substances from a crucible. The sudden chill sets up stresses which cause the cooling substance to burst into small pieces and to break off the walls of the receptacle. Hereby I made the observation that the fused substance represented a transparent glass at places where it formed a thin layer; however, thicker parts of it, which could not cool as rapidly, became opalescent. After repeated attempts I succeeded in obtaining a thin layer of uniform thickness at the bottom of the platinum vessel which, upon cooling, was found to be transparent throughout. The same phenomenon is to be observed in the manufacture of glass whenever a glass is cooled too slowly. Of all the silicates that I produced, the mono-calcium silicate was the only one possessing this characteristic quality.

A product of the same properties was obtained by fusing a mixture of calcium oxide and silica. On a large scale I burnt in a rotary kiln calcium carbonate and quartz sand, which were previously powdered finely and mixed very thoroughly in equimolecular proportions. The product of which several hundred pounds were manufactured, had taken up from the ashes of the coal 2.7% of alumina and a trace of iron oxide, although a coal was used as low in ashes as could be obtained. It was slightly yellow. The temperature of the furnace was the same as in burning Portland cement. The silicate was fused completely and formed long bars that had to be broken with a chisel.

In opposition to Kanter I never observed disintegration of the mono-calcium silicate, though I produced it under varying conditions and from all the different raw materials conceivable.

The Di-Calcium Silicate. The di-calcium silicate is the compound to which generally the disintegrating or dusting of imperfectly proportioned Portland cement is attributed. Zulkowsky, Le Chatelier and also Unger invariably failed to obtain a stable product in

fusing a mixture of calcium oxide and silica in the molecular proportions of 2 to 1. They always obtained a compound which crumbled into dust upon cooling in the air or under mercury.

Zulkowsky observed that disintegration could be prevented, if the red hot fused product was chilled quickly by dropping it in water. This strange phenomenon, which so far has been found to be characteristic only of the di-calcium silicate, has led to widely differing explanations.

Zulkowsky explained it by the existence of two isomeric compounds, an ortho-silicate and a meta-silicate, whereas Le Chatelier attributed it to dimorphism and Hewitt assumed that the di-calcium silicate existed in two allotropic modifications. Michaelis declared that in addition to a faulty chemical composition, burning at too high a temperature was responsible for the disintegration of certain Portland cement mixtures. On the other hand F. Schott put the blame upon imperfect combination of the raw materials, caused by insufficient grinding and mixing, and maintained that a stable di-calcium silicate existed. The temperatures at which the experimenters obtained the product differed considerably. Zulkowsky burnt a slightly sintered di-calcium silicate at the melting point of Seger cone 21. Le Chatelier believed to have obtained a fused di-calcium silicate at the melting point of iron. Rohland stated its melting point to be 1740 centigrade.

I spent a great deal of time and care on the preparation of this compound and on finding the cause of the disintegration. In the beginning of my experiments I prepared a thorough mixture in the ratio of 2 to 1 of the chemically pure calcium oxide and silica formerly described; this was moistened with water and formed into balls of one inch in diameter. Upon previous drying at 100 centigrade, these were exposed for 4 hours in a platinum vessel to a temperature of 1400 centigrade, the burning temperature of Portland cement.

The calcined mixture was found to be covered with a thin vitrified crust, which forms likewise, if limestone alone is burnt over a blast lamp. After the lapse of a few minutes, however, the apparently sintered material crumbled into dust.

Further experiments, for which the mixture was prepared even more carefully, yielded invariably the same result. Hereafter I decided to burn the di-calcium silicate in a blast furnace charged with coke, with which I was able to obtain very high temperatures. For this purpose I surrounded balls of the size of a fist of the di-calcium silicate raw mixture with a half-inch layer of Portland cement raw mixture and burnt until the Portland cement coating began to melt. As the di-calcium silicate mixture shrunk in the burning process more than the Portland cement mixture, the balls inside of the Portland cement touched the surrounding cement only in a single point and, consequently, could be adulterated but slightly. Although the Portland cement mixture was fused completely, which according to my tests required a temperature of about 1600 centigrade, the balls of the di-calcium silicate mixture included in it did not even begin to be vitrified, but could be transformed into powder by the slightest pressure. Also in this case disintegration took place. These experiments, therefore, showed that the burning of the di-calcium silicate mixture required a temperature higher than 1600 centigrade. As a small rotary furnace did not develop the desired heat, I continued my experiments with the electric arc-light furnaces previously described. In

these small kilns I fused the di-calcium silicate in a receptacle consisting of fused magnesia.

Yet, in spite of the blowing magnet employed, I always obtained a dark-yellow fused product of great hardness which, however, upon cooling for about three minutes, disintegrated. The same result was obtained no matter whether I used the silica prepared from silicium fluoride or that from Merck. The disintegrated product was of a faint pink color in every instance. I suspected the carbon particles, which could not be prevented from getting into the fused substance, to be responsible for the cause of the disintegration and, for this reason, used for further experiments the space above the arc-light, where carbon could not reach the substance. The raw mixture was formed into a bar, fastened to a porcelain tube and then introduced above the arc-light. In this manner I succeeded in obtaining a pure white fused product, that, however, upon cooling crumbled into dust in the same way as the former products adulterated by carbon. The only difference was that the resulting powder remained purely white at this time.

These experiments verified the statements of all previous investigators about the di-calcium silicate. But, I was determined to make further tests, presuming that possibly the mixture of the materials had not been sufficiently intimate or that the modification of the silica had something to do with the outcome of the experiments.

A more intimate mixture was obtained by the simultaneous precipitation of silica and calcium carbonate from a mixture of a water glass solution and a solution of calcium chloride in the necessary proportion. 100 grams of water glass solution containing 26.75% of silica required 49.92 grams of calcium oxide or 98.14 grams of calcium chloride. The water glass was diluted with 1000 ccm. of water and made acidous with dilute hydrochloric acid, and the calcium chloride solution was filled up to 5000 ccm. and likewise made acidous by 10 ccm. of concentrated hydrochloric acid. The mixture of both solutions was diluted to 12 liters and then precipitated with a mixture of ammonia and ammonium carbonate, which caused a voluminous, apparently crystalline precipitate that settled immediately. This was washed thoroughly, filtered and dried. Chemical analysis showed the following composition:

Found:	Estimat'd for 2CaO,1SiO ₂
CaO 43.3%	CaO 43.3%
SiO ₂ 22.9%	SiO ₂ 23.1%
Loss at red heat.....34.1%	Loss at red heat.....36.6%

The dried white powder was burned in the arc-light furnace. The resulting fused product did not show any signs of disintegration, but remained perfectly intact. In the beginning of the burning, a distinct odor of ammonia was noticeable. The composition was found to be as follows:

Determined:	Required Theoretically:
CaO 65.5%	CaO 65.2%
SiO ₂ 33.6%	SiO ₂ 34.8%
Fe ₂ O ₃ 0.4%	

The experiment was repeated at once. At this time the mixture was even more perfect. The analysis of the unburnt product yielded:

Found:	Estimat'd for 2CaO,1SiO ₂
CaO 40.8%	CaO 41.6%
SiO ₂ 22.3%	SiO ₂ 22.3%
Loss at red heat..... 36.5%	Loss at red heat..... 36.1%

This raw mixture burnt in the electric furnace fused to a white substance, which likewise did not disintegrate.

The analysis corresponded fairly well with the theoretical composition:

Determined:	Required Theoretically:
CaO 64.53%	CaO 65.2%
SiO ₂ 34.6%	SiO ₂ 34.8%
Fe ₂ O ₃ 0.48%	

Thus I obtained an entirely different modification of the di-calcium silicate, which always had been believed to exist, but which so far had not been obtained by any experimenter. This product showed also a totally different behavior from that of the disintegrated modification as far as their hydraulic properties were concerned, for it set within 6 hours and hardened. As I had obtained only 80 grams of the stable di-calcium silicate by the formerly described method, I made an attempt to prepare larger quantities for further tests. For this purpose I handled amounts ten times as large as before, in carboys, in exactly the same manner as done on a small scale. In order to be sure that all of the silica was precipitated, I used a surplus of ammonia and ammonium carbonate. The washing of the precipitate took an entire day, although it settled immediately.

The analysis, figured for the calcined state, showed:

CaO 78.0%
SiO ₂ 21.9%

hence the product did not contain enough silica.

Also a repetition of the experiment did not yield satisfactory results; I obtained:

CaO 69.1%
SiO ₂ 30.8%

and at a third time:

CaO 70.5%
SiO ₂ 29.3%

I ascribed the missing amount of silica to the fact that I had made use of a large excess of ammonia. In order to obtain some information to this effect, I conducted the following tests: To two quantities of 0.5 ccm. of a water glass solution weighing 0.6353 gram were added, in each case, 6 ccm. of concentrated hydrochloric acid. Then solution No. 1 was precipitated and thoroughly stirred with 14 ccm. of concentrated ammonia water and solution No. 2 with 100 ccm. of concentrated ammonia. The filtered precipitates, which were washed with the same amounts of water, amounted to:

No. 1: 0.158 g equal to 24.9% SiO ₂
No. 2: 0.126 g equal to 16.7% SiO ₂

hence a difference of 8.2%.

The filtrates originating from the washing of the former precipitates were twice evaporated with hydrochloric acid and dried at 110 centigrade for 3 hours. The residue was dissolved with hydrochloric acid and diluted with water. In both cases a flocculent residue of silica remained, amounting:

In the first case to.....1.8% SiO ₂
and in the second case to.....9.2% SiO ₂

This shows that a surplus of ammonia, during precipitation of the silica, dissolves the latter, whereby the ammonium chloride and sodium chloride, which form, may possibly assist in carrying silica into solution.

In the following experiments, I consequently avoided carefully an excess of ammonia. However, I never obtained accurately the desired ratio of

CaO	65.2%
SiO ₂	34.8%

but the percentage of silica varied between 30% and 33.5%.

To the mixture which contained 33.5% of silica I added 1.3% of dried finely powdered silica, in order to arrive at the correct proportions. The mixture then proved to have the following composition:

CaO	64.9%
SiO ₂	34.8%

However, upon fusing a sample of this mixture in the electric furnace, it showed again the characteristic disintegration which I attributed to the admixture of the 1.3% of dry silica.

For subsequent experiments I gradually increased the amount of water glass beyond the proportions theoretically required for the di-calcium silicate and hoped thus to obtain a precipitate of the desired proportions. But, I obtained quite irregularly once too much and the next time too little silica, so that I had to abandon this method also.

It is a well-known fact that the obtaining of the correct proportions between limestone and clay is likewise of the utmost importance in the manufacture of Portland cement on a large scale. The following formula is used for this purpose by the manufacturer:

$$x \text{ equal to } \frac{u - k}{t - u}$$

in which "u" indicates the desired amount of clay, "k" the clay substance in the limestone and "t" the clay substance of the clay. In the same manner, it must be possible to obtain also in the case of my materials a mixture of the desired proportions by mixing a precipitate high in silica with another low in silica in accordance with the above formula. In order to secure a thorough mixture, I did not dry the precipitate at first, but used them in the state of a wet mud after having determined their contents of solid substance, water and carbonic acid. From two precipitates containing 32.0% and 40.1% of silica the proper proportions were calculated as follows:

$$x \text{ equal to } \frac{34.8 - 32.0}{40.1 - 34.8} \text{ equal to } \frac{2.8}{5.3}$$

Hence, 5.3 parts of No. 1 had to be mixed with 2.8 parts of No. II. This procedure resulted in a large quantity of a raw mixture containing:

CaO	64.8%
SiO ₂	34.6%

But also this mixture yielded a fused product which disintegrated upon cooling. In the beginning I tried to explain this result, which was in opposition to my first experiments by imperfect mixing and assumed that in the large carboys, which contained 30 liters, silica and calcium oxide were not precipitated simultaneously by the ammonia and ammonium carbonate and that consequently the desired intimate mixture by the process of precipitation was not obtained. In this event, I expected to secure a perfect mixture by pouring a mixture of the solutions of water glass and calcium chloride into the ammoniacal solution of ammonium carbonate. The precipitates thus obtained were mixed by the aid of the above formula and thus made to correspond with the composition of the di-calcium silicate. Finally they were burnt. Yet, also in this case disintegration of the fused product took place and a white powder resulted from it. As I could not find an explanation for this, I repeated the experiments on a small scale with only 25 grams of water glass and the corresponding amount of calcium chlo-

ride solution. Two mixtures prepared at the same time and in identically the same way, the composition of which corresponded almost exactly with the theoretical amounts, showed the surprising result that one crumbled into dust after being fused, while the other remained perfectly intact. Both mixtures had been treated in precisely the same manner, had been washed with the same amounts of water and been filtered at the same time and yet behaved so differently. The sole difference during their preparation consisted in the washing of the precipitates, which was done in a high cylindrical vessel in one instance, namely the disintegrated product, and in a low vessel in the case of the stable modification. This led to the presumption that, on account of the different specific gravity of the precipitated silica and calcium carbonate, unmixing may have taken place in the high vessel. This fear, however, was unfounded, for further experiments yielded mostly the disintegrated product, whereas the stable form was only rarely obtained, although all experiments were made under the same conditions. All my efforts to explain this strange phenomenon by frequent repetitions of the experiment with slight deviations proved to be in vain. Whenever I prepared large quantities of the mixtures, I obtained the disintegrated product and the result was, with a few exceptions, the same in the case of the experiments on a small scale.

This experience, in my opinion, entitled me to assume the silica to exist in various modifications. This belief was confirmed by the publications by Mylius and Groschuff whose experiments, to be true, extended only over silica in solution, hence applied to colloidal silica or to water glass solutions. According to the method of treating the silica, Mylius obtained either a preparation which was precipitated by albumen or which was not precipitated by it.

From the foregoing I drew the conclusion that the two modifications of di-calcium silicate contained different forms of silica, of which one yielded a stable compound, while the presence of the other caused the di-calcium silicate to disintegrate.

For this reason, I prepared mixtures of colloidal silica and calcium oxide. The colloidal silica was obtained in the manner previously described.

A liter of a solution containing 0.9% of colloidal silica required 16.8 grams CaO or 33 grams of calcium chloride.

The calcium chloride was dissolved in water, 50 ccm. of diluted hydrochloric acid were added to it and this was mixed with a liter of the solution of colloidal silica, whereby the silica remained in solution. Only if the mixture was left alone for a long time, a suspension was formed. Therefore, the experiment was conducted with the necessary speed.

The mixture of the solution was made ammoniacal and then precipitated with ammonium carbonate. The precipitate which, according to Kanter, consisted of meta-silicate and free calcium carbonate, was very voluminous; it was washed repeatedly and filtered. The analysis gave the following composition:

CaO	52.7%
SiO ₂	27.7%
Loss at red heat.....	19.3%

hence, 0.6% of silica were missing.

The fused product burnt from this mixture in the electric furnace likewise disintegrated upon cooling.

The same result was obtained with a mixture prepared from colloidal silica and lime-water. Consequently neither imperfect pulverizing nor insufficient mixing can be the true cause of the disintegrating.

Thus, the explanation for the strange conduct of the di-calcium silicate, disintegrating upon cooling in one case and remaining stable in another, had to be looked for in a different direction. Therefore, the complicated method of mixing by simultaneous precipitation was of no avail and, for this reason, I returned again to the previous method of mechanical mixing.

The firm of Merck & Co. prepared for my purposes a gelatinous silica of exceptional purity, which I received in a moist state and which I employed for all further experiments. It contained 10.5% of silica. A mixture of 571 grams of this moist silica and of 230 grams of calcium carbonate was passed repeatedly through a 100-mesh sieve and resulted in a product resembling starch paste. After having been dried on a water-bath, it could be moulded into any shape desired.

Michaelis ascribed the disintegrating of Portland cement to an excessively high burning temperature; possibly this was the cause of the crumbling into dust of the di-calcium silicate. Yet, it was improbable, as the di-calcium silicate of my first experiments, which was burnt at a very low temperature, likewise disintegrated.

The raw mixture corresponding with the di-calcium silicate was formed again into hollow cylinders and burnt in the electric furnace, represented by cuts No. 11 and 12, at 60 amperes and 135 volts. The time of burning was about 20 minutes. But also in this case the result was the same. Several times some of the cylinders remained perfectly intact after having been burnt and then again some of them disintegrated completely. But, in most cases I obtained one-third of the substance as stable compound, whereas two-thirds were transformed into powder. In this manner I burnt more than a hundred cylinders of the composition of the di-calcium silicate without being able to find a satisfactory explanation for the different behavior of the burnt cylinders. I observed in every instance that the inner, more strongly burnt or fused part of the hollow cylinder, disintegrated less than the outside.

While in the burning of Portland cement and of calcium aluminates and calcium ferrites, and likewise in the burning of mixtures of silica, alumina and calcium oxide, the process of sintering and fusing proceeds gradually through the whole mass, apparently in consequence of the fact that the mass represents a very poor heat conductor, the mixtures of calcium oxide and silica show an entirely different behavior. No gradual sintering of the whole mass takes place upon burning, but, only at the highest temperatures required for the burning, an almost sudden partial softening of the mass becomes noticeable. A similar conduct was observed in the case of hollow cylinders made of pure calcium oxide.

The disintegrated di-calcium silicate frequently consisted of a fine powder and of grains, from one-fortieth to one-sixteenth of an inch in diameter, of the stable modification. My attention was called to this, when I observed that also the disintegrated part hardened sometimes upon mixing with water. The fine grains were separated from the powder by screening through a 100-mesh sieve. The grains remaining on the sieve were then ground to a powder and were found to harden well, whereas the powder which passed the 100-mesh sieve did not harden at all.

The di-calcium silicate behaved in an entirely different way, if it was fused in the arc-light. In this event, a slightly grey pearl was obtained which disintegrated completely upon cooling. That complete disintegration did not take place in the case of the hollow cyl-

inders I believed to be due to the circumstance that the stresses set up during cooling were distributed over a larger area than in the case of a small pearl. This explanation, however, did not satisfy me, for, as formerly described, also in this furnace fused products were obtained several times which did not show the least inclination of crumbling into dust.

Zulkowsky obtained a stable modification of the di-calcium silicate by quickly cooling the fused product. I tried this method also, but the result did not differ materially from my former experience.

I dipped the cylinder, taken out of the furnace at white heat, immediately into cold water. It seemed to remain perfectly intact; however, when I took it out of the water after several minutes, it dried rapidly, because it was still hot, and disintegrated, and furnished only one-third of its volume of the stable modification. The disintegrated part separated from the coarse by a 100-mesh sieve, resembled in every respect the disintegrated part originating from the fused product which was not chilled in water. Also quick cooling by means of a current of cold air, directed by a blower upon the fused product, did not prevent the disintegrating of the largest part of the cylinder.

These experiments ended the long series of tests made with di-calcium silicate mixtures. Hereafter, I prepared a mixture of the composition $2.5\text{CaO} \cdot 1\text{SiO}_2$, a product which does not answer any chemical formula, but which represents an intermediary product between the di-calcium silicate and tri-calcium silicate. I selected this composition, because I observed blowing in the case of the "tri-calcium silicate," which latter will be described later, while I never noticed even signs of it during the hardening of the di-calcium silicate. In the manufacture of Portland cement the aim is to proportion the raw mixture so high in lime that just the limit is reached beyond which blowing would set in. Experience teaches that this yields the highest quality of cement. A surpassing of this so-called lime-limit by one per cent is generally sufficient to render the finished cement unsound. It was of interest, therefore, to ascertain which percentage of lime formed this limit in the case of the pure calcium silicates. The composition of the commercial Portland cement made it probable that the mixture of $2.5\text{CaO} \cdot 1\text{SiO}_2$ represented this limit, and this in fact seems to be the point where blowing begins, as I shall prove in the following:

In preparing the mixture and in fusing it I was guided by the experience gained from the di-calcium silicate. It behaved in every respect in exactly the same way as the di-calcium silicate, no matter whether it was obtained from an intimate mechanical mixture of the ingredients or precipitated from a mixture of the solutions of silicate and calcium chloride. As soon as it cooled down to a certain temperature, disintegration took place which, even more frequently than with the di-calcium silicate, extended over the whole fused mass. In most cases, however, I obtained also one-third of this product as stable modification and two-thirds as powder. However, all pearls, fused throughout, disintegrated every time, though I repeated the experiment more than a hundred times, whereas from the di-calcium silicate non-disintegrating pearls were obtained several times. Only by fusing of the mixture in the direct arc-light I obtained a brown product, which disintegrated only partly; the remaining part broke only into several pieces.

The fractured surfaces frequently showed a strongly light-refracting crystalline structure. But, the color as well as the analysis revealed that the product did not merely represent a mixture of calcium oxide and

silica, for several percent of calcium oxide were always missing; these were combined with carbon to calcium carbide. The temperature of the space above the arc-light was not sufficient to fuse this high-limed product. Only in the arc-light fusing of the mixture was possible. The di-calcium silicate, which did not require as high a temperature, as the reader will remember, could still be obtained as a pure fused substance in the space above the arc-light. In other respects, however, the $2.5\text{CaO}, 1\text{SiO}_2$ mixture behaved in exactly the same way as the di-calcium silicate.

THE TRI-CALCIUM SILICATE: In the opinion of Le Chatelier and of a number of other experimenters, a "tri-calcium silicate" forms the active part of Portland cement. In accordance herewith a number of complicated formulae have been advanced to make the six-valency of the silicic acid possible. However, a discussion of such formulae is absolutely unnecessary, because no one has ever been able to prove that a tri-calcium silicate really exists.

Although Zulkowsky and Oddo believed a similar compound to be out of the question and though Jordis and Kanter declared in 1902 that it had been definitely proven that a tri-calcium silicate could not possibly exist in Portland cement, in recent years several attempts have been made to prepare this hypothetical compound by synthesis.

Thus Newberry and Smith believed to have obtained, by fusing in an oxy-hydrogen flame, a tri-calcium silicate which contained only 0.88% of alumina. Their product hardened; however, they did not succeed in producing even enough of it to make a test piece.

In a similar manner, Unger obtained a fused product of the composition

CaO	73.61%
SiO ₂	26.29%

which was even purer than the former. This was prepared in an electric furnace by fusing of a mixture of calcium carbonate and silica which was exposed for 10 minutes to an arc-light at 100 amp. and 120 volt. Upon cooling, the merely vitrified parts disintegrated and only the fused portion remained intact. The fused product was crystalline, but all that could be said about the crystals was that they were not identical with the products claimed to have been obtained by Le Chatelier and Toernebohm. After having been mixed with water, the material started to harden in the beginning, but was transformed into a mud in a short time.

I repeated Unger's experiment under exactly the same conditions and obtained a fused product which did not disintegrate, but which was gray on account of the carbon particles from the electrodes, no matter whether I heated for 5 or 10 minutes. The product was crystalline. The analysis showed, in the best case, 97.8%, namely:

CaO	72.1%
Al ₂ O ₃	0.4%
SiO ₂	25.3%
	97.8%

Hence, 2.2% were missing, while otherwise the composition apparently coincided with the tri-calcium silicate. The molecular proportions of CaO to SiO₂ were 2.7 to 1. If we assume the missing 2.2% to be carbon combined with the calcium as calcium carbide 3.7% Ca or 5.18% CaO were combined with carbon, and only 66.92% CaO were combined with SiO₂, which by no means corresponds any longer with the tri-calcium silicate. Therefore, a totally different behavior was

observed from that of the pure "tri-calcium silicate," as will be shown afterwards.

The carbon was uniformly distributed throughout the fused mass. Moistening with water revealed only a slight odor of acetylene. Some of the fused products were of a crystalline structure, which, however, may have been due to the calcium carbide. In order to avoid these adulterations I made use of all the different kinds of carbon electrodes, but did not improve anything. Also an electro-magnet, which was expected to blow the carbon particles away, was of no avail. The minimum of carbon in the fused products was 2%. A portion of this stable "tri-calcium silicate" which was kept in an imperfectly closed jar for half a year, was found to be disintegrated with the exception of a few fragments. The loss at red heat of this aerated product amounted to 13.5%.

The only remaining method of producing a pure "tri-calcium silicate" was to mould it into hollow cylinders and to fuse it in the electric furnace. In this case, I had to expose the cylinder to the radiating heat of the arc-light for a much longer time than with the di-calcium silicate, namely from 30 to 40 minutes. The fused product behaved in identically the same manner as the di-calcium silicate, that is to say, two-thirds of the product disintegrated upon cooling. The inner part of the cylinder, which was fused to a crust, broke into several places, but did not crumble into dust. More than a hundred experiments were made in this manner and yet, the fused mass did not remain perfectly intact even in a single instance.

CONCLUSIONS DRAWN FROM EXPERIMENTS WITH LIME-SILICA MIXTURES: The result of my experiments differs from those of most previous investigators in as much as I found that disintegration of the burnt product is not at all characteristic only of the di-calcium silicate, but is to be found even more pronounced with all lime-silica mixtures higher in lime than the di-calcium silicate. While, in several instances, stable fused mixtures were obtained answering the composition of the di-calcium silicate, this was impossible as soon as the calcium oxide exceeded the ratio 2CaO to 1SiO_2 . It was of equal importance to know how far the contents of lime had to be decreased in order to prevent disintegration at all. A mixture of the composition 1.5CaO to 1SiO_2 showed the same phenomenon, but in a lesser degree. Disintegration could be entirely prevented in this case by quickly breaking the red hot fused product with a hammer into a number of pieces; otherwise the product crumbled into dust and only a few small pieces were left intact. As previously stated, the mono-calcium silicate did not disintegrate in a single instance. The fused products resulting from mixtures between the mono-calcium silicate and di-calcium silicate formed a yellow glassy substance. Two of these fused products were kept in well-closed jars. After a year, both of them were found to be disintegrated into a white powder, in the same way as the fused "tri-calcium silicate" formerly described, and only a very few compact small pieces were obtained upon screening. The composition of these two products was the following:

I.	CaO	59.2%
	SiO ₂	40.3%
II.	CaO	55.8%
	SiO ₂	43.8%

The cause of the disintegration could be ascribed either to insufficient heating or to an excessive burning temperature. In order to decide this point all mixtures were burnt at varying temperatures.

The mixtures were moistened with water, moulded into balls and burnt for 3 hours at 1300 centigrade.

For all mixtures higher in lime than the mono-calcium silicate the temperature of 1300 centigrade proved to be insufficient to bring about chemical reaction between calcium oxide and silica. The balls were dried, but did not show any signs of combination. Now, the same balls were heated for 4 hours at 1400 centigrade.

When, upon cooling of the furnace, the platinum vessel was taken out, the balls were found disintegrated into a fine powder which was distinctly crystalline. This is the same phenomenon which Zulkowsky and Le Chatelier always observed in the case of the di-calcium silicate and which is due solely to insufficient heat. Only at a temperature above the melting point of platinum the stable di-calcium silicate is formed wholly or partially and, upon further increase of the temperature, the assumed tri-calcium silicate. Insufficient heat was always the cause of the disintegration of the entire mass.

A further proof for the correctness of this assumption was the fact that, during the burning of lime-silica mixtures on a large scale, all fused products higher in lime than 1.5 CaO to 1 SiO₂ disintegrated immediately after dropping out of the rotary furnace.

Imperfect mixing further contributes towards making the process of disintegration complete. Even the mixture corresponding in composition with the mono-calcium silicate crumbled into dust after having been burnt at 1300 centigrade in all cases in which the mixing was done insufficiently. Jordis and Kanter had the same experience with the mono-calcium silicate, which plainly showed that they worked with imperfect mixtures. Prolonged heating was likewise without influence upon the stability of the product. Disintegration set in even after the temperature had been kept at the melting point of the mixture for 5 hours. Also attempts at burning the cylinders at first on the outside in furnace No 13 and afterwards on the inside in furnace No. 11 and 12 were equally unsuccessful.

(To be Continued.)

MANUFACTURE AND USE OF SLAG CEMENT AND OTHER SUBSTITUTES FOR PORTLAND CEMENT.

By W. D'Rohan.

The use of concrete in the irrigation construction of the west has long since passed the experimental stage and become an absolute necessity. The headworks and reservoirs of the various canals are always situated way up in the mountains, remote from a railroad and in most inaccessible places, so that very often engineers are forced to abandon the works as the great cost of freighting to those places swallow up the limited funds at their disposal.

The principal material to be hauled for the construction is cement. The others can always be found in close proximity to the works and as there is a probability of a big increase in the cost of cement to the consumer, owing to the recent combine of manufacturers, a cheap and efficient substitute becomes a necessity for the irrigation engineer and the homesteader.

The following paper briefly describes how these substitutes can be practically home-made very cheaply by any one with a little care and the material tested before and after manufacture, with little trouble. The various recipes given are not experiments, but have

been used in Europe, Africa and India for many hundreds of years, and give concretes which offer an absolute resistance to alkali and acid bearing waters.

Every engineer is acquainted, theoretically at least with the manufacture and use of Puzzolan cement in Italy and Puzzolan-Trass cement in Germany and Holland. The old Roman cement belonged to this class of Puzzolans, and all the substitutes offered in this paper must be classified as artificial Puzzolans belonging to this category.

The principal artificial Puzzolan cement made in this country is manufactured by grinding with slaked lime, blast-furnace slag which has previously been granulated by a large stream of water at great pressure. This must not be confused with a true Portland cement made by mixing limestone and slag, grinding very finely the resulting mixture and burning to a clinker. For this latter, the slag must come from furnaces working only pure ores and fluxed with low magnesian limestone, and must not contain more than 48 per cent of silica and alumina; 3 per cent of magnesia or 12 per cent of iron.

For the manufacture of Slag Puzzolan, any slag is available, thus placing the refuse heaps of the numerous smelters throughout the west at the disposal of the engineer. The slag is granulated as above, then a small quantity of this slag is ground up with the slaked lime to a fine powder and the resulting cement tested; if satisfactory, the actual manufacture starts; if otherwise, more or less time is added until the best results are obtained; if slow setting, it is customary to add 2 to 4 per cent of caustic soda or potash to hasten the setting. This soda is generally added to the water used in slaking the lime and as it quickly carbonizes, slag cement becomes slow setting again with long storage.

Pulverizing this slag is a very laborious proceeding and as only large jobs permit the installation of special grinding machinery, this cement, as a home-made product, is hardly likely to appeal to the hustler; still, it is found in England that one laborer can pulverize from 20 to 30 cu. ft. per day using a heavy, flat concrete tamping iron; that is from 5 to 8 barrels per day and 85 per cent of it will pass through a 180 mesh sieve.

Puzzolan cement made from slag is characterized physically by its light lilac color; the absence of grit attending fine grinding and the extreme subdivision of its slaked lime element; its low specific gravity (2.6 to 2.8) compared with Portland (3 to 3.5) and by the intense bluish green color in the fresh fracture after long submersion in water, due to the presence of sulphides, which color fades after exposure to dry air.

This Slag Puzzolan is essentially a hydraulic cement and is generally for use in foundations and under water. It disintegrates after 3 or 4 years when in dry air, owing to the oxidation of the sulphides in the atmosphere. The disintegration can be easily prevented by the use of oil in the mixing. Half a gallon per yard is sufficient, linseed, olive or asphaltic base oils being used.

The drainage system of New Orleans was built of this Slag Puzzolan cement and is the finest work of its kind.

Artificial Puzzolans are pulverized brick or tile, broken pottery and glass, burnt clay, wood, and bone ashes, charcoal, powdered pumice stone and the scoria of forges, and all are available in the manufacture of cements. The use of pulverized bricks, tile and burnt clay in the manufacture of hydraulic mortars extends from remote ages to the present day. An analysis of the mortar in the ruins of the Palais des Fermes in Paris, built by the Romans, shows that 26.10 of pulverized bricks, tile or burnt clay, with 65.70 parts of lime, 4 silex and 4.20 alumina formed the mixture.

A cement much used in India is made of 1 part slaked lime and 1½ to 1 part of finely ground brick dust.

Count Chapal calcined ochrey clays and made a good Puzzolana. M. Mason sunk casks filled with them in the Seine and after six months were found to be extremely hard.

General Treussart states that a mixture of common lime with sand and powdered brick in equal parts forms a hydraulic mortar requiring a breaking weight of from 221 to 221 lbs., which he considers sufficient for general purposes; he found, however, that bricks exposed to a current of air while burning, make a quicker setting cement than those not so exposed.

The present custom of Italians and French is to throw up clay and fuel loosely together and burn it slowly, then grind it up with slaked lime, using 1 part lime to $1\frac{1}{2}$ parts clay. A laborer can pulverize 30 cu. ft. or 8 barrels of this material in a day. To this mixture is added 2 or 3 per cent of alkali, either soda or potash, for the purpose of forming a soluble silicate to act upon the lime in setting and sometimes 1 per cent of finely pulverized quartz or sand rock is added.

A cement of equal parts of unslaked lime, pulverized charcoal and powdered sandstone was discovered in the Mausoleum of a Tartar Prince. It was so hard that the bricks could not be pulled apart without breaking.

Coal ash mortar was used by Col. Fanshawe at Water Point Gibraltar in 1790-1, and is still in good shape.

Masons cement, that will not crack under water, is made of equal parts of quicklime, pulverized baked bricks and wood ashes. Thoroughly mix and dilute with sufficient olive oil to form a manageable paste. It immediately hardens and does not crack.

Common mortar of ashes is made by mixing together 2 bushels of newly-slaked lime, 3 bushels of wood ashes, which, when cold, is to be well beaten. The oftener beaten before being used, the better. It is an excellent mortar of resisting alternate moisture and dryness.

Two bushels of slaked lime, 1 of burned clay and 3 of sharp sand, to which can be added the aggregate, is a good water concrete.

One bushel of pulverized quicklime, 2 of slaked lime, and one of burnt clay or brick dust, with as little water as possible, makes a good cement. Boiled potatoes incorporated with lime and sand or burnt clay, improves it. (Austin 1871.)

Dr. Shaw gives the following description of a Maltha used in Tunis and other parts of Africa: 1 of sand, 2 of wood ashes and 3 of sifted lime powder, mixed with a little water. When well incorporated, add a little oil, and beat up once every day for four days, regaging with a little water and oil. This makes a splendid hydraulic cement, harder than granite.

Dr. Brindley Higgins of London, possibly the greatest experimenter of his day, with limes and cements, patented a cement, as follows:

Fifty-six pounds coarse, washed sand, and 42 pounds fine sand, mixed together and wet with lime water; then add 14 pounds of lime and 14 pounds of fine bone ashes. If for use under water, use only 5 pounds of bone ashes. This cement was extensively used with great success in England.

M. Baggi of Gottenburgh, made use of a very hard, black, schistous rock, which he burned for a considerable time and afterwards pulverized and mixed with lime to make a good hydraulic mortar.

Mr. John Smeaton in 1756 used a mixture of 1 part of lime with 1 part of Puzzolana as a mortar in building the Eddystone Light House, which by its durability, earned for him, undying fame as an engineer.

Silenitic mortar which is very commonly used in England, is made by the addition of from 2 to 4 per cent of sulphate of lime, (plaster of Paris or gypsum) or green vitrol. This addition saves half the lime, is four

times as strong and is an excellent substitute for Portland cement.

M. Vicat recommends testing all Puzzolanas by acids, recommending diluted muriatic or nitric acid, and in lime water. (1) It will be found that those not acted on by the acids, and having no action on lime water, are inert. (2) Those that are moderately acted on by acids, and act moderately in lime water, have very little energy. (3) Those which are powerfully acted on by acids and which are active in lime water, are energetic.

From the analysis of Portland cement and the foregoing recipes, it will be seen that lime is the principal active agent in all cements, whether Portland, natural or Puzzolana. The only exception probably is magnesian cement in which pure carbonate of magnesia, called magnesite, when burnt in a heat of great intensity, about cherry red, ground to a fine powder and made into paste with water, possesses considerable hydraulic energy. This calcined magnesite has been patented under the name of Union Cement. Its characteristic property, however, upon which it depends for its peculiar value, is not developed when mixed with water alone, for in that case the induration or setting is due to the crystallization of the hydrated magnesia or oxide of magnesium. But if the burnt and pulverized magnesite or Union Cement be mixed up with chloride of magnesium, for which the bittern water of seaside salt works has been found to be a cheap and suitable substitute, a chemical combination takes place between the oxide and the chloride of magnesium and oxychloride of magnesium is formed. This is a very remarkable hydraulic cement, being greatly superior to any other new cement in strength and hardness, not excepting even Portland cement.

Owing to the enormous deposits of lime-stone in the United States, the ease with which lime is manufactured, and as only caustic or hot lime is to be used in the manufacture of the Puzzolans, it will be seen that these cement substitutes can be made at about one-third the cost of Portland cement. Lump lime can usually be purchased at one-fourth the price of cement. Besides the freight is almost eliminated. Where lime is not conveniently to be had, there is nothing to prevent its manufacture. In every gang of Irish or Italian laborers will be found one or two men who have burned stones in the old country and they can be depended upon to produce good lime. Limestone, chalk or marl deposits are usually burned, but nearly all calcareous and carboniferous stones make good lime. They acquire the properties of lime in the highest degree when they are slowly heated in small fragments until they appear to glow with a white heat, when this is continued until they become non-effervescent.

If a man decides to burn his own lime, the first thing to do is to test the rock available. This is done with ten cents' worth of diluted nitric or muriatic acid and an ordinary water glass. Drop a small piece of rock into the acid in the glass; if no action takes place, the rock is not suitable; if it effervesces and falls to pieces, the search is successful. This rock can now be further tested by burning four or five small pieces in an ordinary fire until they do not effervesce with the acid. Grind them up when cool and make into a paste with water and 50 per cent clay or powdered brick. The boiling test can now be applied as in the case of Portland cement, and the percentage of clay increased or diminished accordingly. Too much lime cracks the paste and too much clay disintegrates it. In this way a first-class cement can be made.

Burning the rock in the open air is a slow proceeding, but it is said to be beneficial, owing to the amount of carbonic acid which the lime absorbs from the air. Generally speaking, however, it is much better to put up a kiln in the shape of a large bottle. It can be built of rocks and mud, with a grating made of any old irons or rails, and

should be so arranged that the draft can be checked. On this grating is laid the fuel, over which the rock is loosely placed, the first row in the shape of an arch, and the rest loosely piled in. The heat is slowly applied at first by means of the draft check, and burning is completed when a piece of the rock does not effervesce in the acid. This takes from 15 to 20 hours. This lime is ready for immediate use. Sometimes, however, the lime is allowed to stand for several months after slaking before being used, and this practice is said, in some instances to increase the hydraulic energy of the product, probably in consequence of the partial recarbonization of the lime, facilitating the process of silification which takes place between the lime and the alkaline silicates contained in the Puzzolana.

From the foregoing, necessarily outlined, description, it is evident that anyone can manufacture a good cement from materials at his disposal. The fallen timber in our forests can supply charcoal and wood ashes; sawdust from the mills, broken bricks, tile and pottery are all available. Puzzolan cements are naturally weaker than Portland, and the former require a little more careful and longer mixing and less water. It was a maxim among the old masons to their laborers that they should dilute the mortar with the sweat of their brows; that is, labor a long time, instead of drowning it with water to have it done sooner. It must be remembered that these Puzzolanas have stood the test of time, and Portland cement is comparatively new.

The hardness of the Roman cement discovered in modern times is attributed to several circumstances. The Romans built their walls of great thickness, and thick walls constructed of materials which are bad conductors of the atmospheric fluids always preserve a latent humidity, more or less sensible according as the distance between the faces of the wall is more or less great. It is well known that the temperature of a block of building, in consequence of the inductivity of its elements, varies but little. Here we have the secret of the hardness of old Roman cement or mortar; it is a hydrate of lime, and thus, instead of being destroyed by humidity, as a plaster or common lime would be, it benefits by it just as aquatic plants thrive on water; moreover, a uniform temperature is peculiarly suited to its preservation. The scrupulous care which the Romans took in the selection of their materials is a grand element in the duration of their constructions. Stone was not employed until it had been exposed to the effects of the air for two years, and if, at the end of that time, it did not appear sound, it was broken up and used for filling the foundation walls. When the cement was used for covering surfaces, the Romans were accustomed to lay it on thick, sometimes to the depth of four or five inches, and it is evident that such a solid coating would last much longer than a thinner one, and have a great effect on the preservation of the walls themselves.

These home-made cements can stand larger doses of sand than the ordinary Portland cement. For mortar, 1 part cement, 4 of sand, will be found sufficiently strong for general purposes. For concrete 1, 3 and 5 mix will be about the best. It is advisable to use lime water when mixing and as little as possible. As Puzzolan cements set very slowly, the forms for concrete work should be left on for at least 14 days. If, after six months, the walls are washed three or four times with equal parts of silicate of soda and potash, dissolved in six parts of water, it will be found that the concrete is much harder than the average Portland. The silicates can be purchased for about a cent a pound. The usual tests of Portland cements can be applied to those Puzzolans, as well as those of Vicat, quoted above.

Slag cement usually exhibits a slight discoloration after boiling, which, however, is harmless.

FUEL REQUIREMENTS OF THE ROTARY KILN.

It is reported by Prof. W. S. Landis, of Lehigh University, that a type of cement kiln is now being developed in Europe which is expected to bring the fuel consumption for burning clinker down to 35 lb. per barrel. In the same article, which appeared in "Metallurgical and Chemical Engineering" for September, he asserted the belief that cement would be burned in the Lehigh region with less than 50 lb. of coal per barrel before long. This low figure will be attained by reducing the losses of heat at the various stages of the process, which Professor Landis indicates in his article substantially as follows, the notes relating only to Lehigh district conditions:

Five hundred and sixty pounds of the raw material, called "mix," are fed to the kiln to make a barrel (the unit weight) of clinker, weighing 380 lb. The mix will average 33 per cent, or 188 lb. per barrel of clinker, of carbon dioxide, existing in the raw material as calcium carbonate. The only reactions taking place in the charge in the kiln are the driving off of the carbon dioxide and the sintering together of the rest of the ingredients to form the clinker. The mix is artificially dried before fine grinding, so that here we are not concerned with driving off water from it.

The calculation of the heat requirements of these reactions is quite as simple as the reactions themselves. The heat of decomposition of calcium carbonate is 1020 lb.-cal. per pound of carbon dioxide, so that to decompose the carbonate present requires $188 \times 1020 = 191,760$ lb.-cal. The sintering of the residue of ingredients is really the chemical union of the silica, lime, and alumina, etc., giving out heat in reaction.

By the combustion of a given weight of mix with a coal of known calorific power in a bomb calorimeter Professor Landis has evaluated the heat of formation of the clinker as 200 lb.-cal. per pound. This figure is not quite accurate, but its limit of error is well within that of the more commonly accepted thermo-chemical data. The formation of clinker will then generate $380 \times 200 = 76,000$ lb.-cal.

The net heat absorbed in the kiln per barrel of clinker, to be supplied from external source, is:

Heat of decomposition of carbonates....	191,760 lb.-cal.
Heat of formation of clinker.....	76,000 lb.-cal.

Net heat absorbed.....115,760 lb.-cal.

From a number of calorimeter determinations of the calorific powers of the long flame bituminous coals used in the Lehigh region for firing the kilns this figure was found to average 7400 lb.cal. per pound of coal. The kiln will therefore require a minimum of 15.7 lb. of coal to produce the reactions necessary for clinker formation irrespective of its kind and size.

It must be remembered, however, that the dissociation of calcium carbonate requires a temperature of 700° to 800° C., depending somewhat on the partial pressure of the carbon dioxide in the atmosphere of the kiln, and also that the formation of the clinker only takes place at temperatures between 1200° and 1300° C. Unfortunately, such temperatures cannot be attained in a continuously working apparatus without considerable losses of heat. The figure for minimum coal requirement just calculated has but little significance to the kilnman operating under industrial conditions. The inevitable losses bring the fuel consumption to many times this theoretical figure.

A large number of heat balance sheets which Professor Landis has made on kilns 60 to 135 ft. long, operated under various superintendents, and always under actual working conditions, suggest the following conclusions:

In a kiln burning pulverized bituminous coal of 70 per cent total carbon and a mix containing 33 per cent carbon dioxide, perfect combustion should result in a chimney gas of the approximate composition (dry): carbon dioxide, 36 per cent; nitrogen, 64 per cent by volume. Both the coal and the mix being dried before grinding; the only moisture that would accompany this gas would be that from the combustion of the hydrogen in the coal. This composition was calculated from a coal consumption of clinker, which will be discussed later.

In no case has the actual chimney gas analyzed anything like this figure, when the samples were taken under the actual operating conditions. An average of these analyses (dry) taken on mills in various parts of the region was carbon dioxide 14.5 per cent, oxygen 9.5 per cent, nitrogen 76 per cent, showing the presence of large excess of air. This air gets into the kiln through the nozzle feeding the coal into the kiln and through leaks around the lower end of the kiln and various sight and poke holes invariably left open.

No attempt seems to be made to control the leakage, as very few of the plants are equipped for the analysis of stack gases and the interpretation of the results. The height and sizes of chimneys seem to have been a matter of guess; they are all too high, and poor regulation of drafts is obtained by opening a door leading to the outside at their base, so admitting cold air.

Kilns burning from 80 to 100 lb. of coal per barrel of clinker, discharging the products of combustion into the stack at 500° C. (average of actually measured temperatures), lose up the chimney 130,000 lb.-cal., for the lower fuel consumption with perfect combustion to 275,000 lb.-cal. for the higher fuel consumption with average excess air. These figures have been taken from balance sheets of actually operating kilns, the first figure from a 135-ft. kiln using 84 lb. of coal and the second figure from a 60-ft. kiln using 100 lb. of coal per barrel of clinker. In terms of pounds of coal the fuel consumption of the smaller kiln was 15 lb. too high because of excess air in products of combustion and 5 lb. too high because of the kiln being too short for efficient heat regeneration.

A curious coincidence in connection with the thermal study of the kilns as actually operated was the fact that the temperature of the gases leaving the kilns, irrespective of the fuel consumption and length of the kilns, was in all cases very close to 500° C. At first glance it looks as if the length of the kilns had but little to do with the extraction of heat from the gases passing through them, but really such is not the case. This temperature is dependent not only on the extraction of heat from the gases, but also on the fuel consumption, amount of air used in combustion, and in radiation losses of the kiln. It was just a coincidence that in all cases studied these items balanced so as to give nearly the same temperature.

It has been mathematically proved that the most economical temperature, as far as the chimney is concerned, is to have the gases enter at 300° C. There is nothing to be gained by introducing the gas into the chimney at 500° C. The heat in the gas equivalent to the difference in temperatures of 500° and 300° C. had better be used for drying purposes. With gases at 300° instead of 500° C. the coal requirement for the chimney could be cut down from 13.5 to 8 lb. per barrel, if the heat equivalent to the difference in temperature was intercepted in the kiln.

The loss of heat in the hot clinker leaving the kiln is a large item. The clinkering temperature is absolutely fixed so that practically all kilns discharge clinker at the same temperature, 1050° C. for their region. The specific heat of clinker is 0.207+0.000019t. The heat in a barrel of clinker at 1050° C. is 90,500 lb.-cal., equivalent to 10.5 lb. of coal. Practically all American kilns discharge this

hot clinker to a conveyor and run it to cooling towers, taking extra precautions to lose all the heat contained. Abroad it is run through an under-cooler, giving up two-thirds to one-half its heat to the air entering the kiln. Such regeneration easily results in a saving of from 5 to 7 lb. of coal, an item well worth considering where we are turning out millions of barrels of cement annually. The cost of an under-cooler is small in comparison with the saving that results from its use.

Numerous measurements made of the temperature of the outside of kilns of all sizes have failed to lead to any concordant results as far as calculation of the radiation loss to 100,000 lb.-cal., a coal consumption of 13.5 lb. the surfaces in the average kiln-room which receive the radiant heat so complicates the calculation that up to the present a direct estimation of this loss is not possible.

One thing is certain, the surface of the kiln will not radiate more heat than it receives by conduction through the lining. If it is possible to back up the shell with a suitable heat insulator and then inside of that put the alumina bricks or other lining used, the radiation losses of the kiln will be reduced considerably. Magnesia or alumina bricks are too good heat conductors to rest directly against the shell of the kiln for economical operation. Years ago an asbestos layer was tried in just such a composite lining as advocated, but its yielding character precluded mechanical stability.

What is wanted is a more firm material of low heat conductivity, and it has occurred to Professor Landis that bricks of infusorial earth, such as the "moler," would well fill this qualification. Tests made in the author's laboratory have shown an abnormally low heat conductivity for these brick; they will stand up sufficiently rigid to temperatures of 700° to 800° C. The great shrinkage can be taken care of by burning them at a temperature slightly higher than they will afterwards be called upon to withstand. The regular refractory lining of alumina bricks can be laid right against the moler bricks.

Some radiation and conduction losses taken from heat balance sheets of various kilns are here reproduced:

60-ft. kiln, old lining.....	268,000 lb.-cal.
100-ft. kiln, new lining.....	176,000 lb.-cal.
135-ft. kiln	255,000 lb.-cal.

The figure on the 100-ft. kiln is the lowest value ever found by Professor Landis for this loss, and represents the nearest approach to perfection in a single-material kiln lining. It corresponds to a coal consumption of 23.5 lb. A composite lining as described should reduce the loss to 100,000 lb.-cal., a coal consumption of 15.5 lb. per barrel of clinker.

To sum up the coal consumption of the kilns this will be:

Reactions	15.7 lb.
Chimney loss, 500 deg., combustion perfect....	13.5 lb.
Clinker loss, no regeneration.....	10.5 lb.
Radiation and conduction loss, ordinary lining..	23.5 lb.
Total	63.2 lb.

These figures represent conditions as actually met in one kiln or another, though not all on the same kiln at the same time. If however, they can be attained individually, says Professor Landis, there is no reason why, under intelligent supervision, all the conditions which originally assured them should not be applied simultaneously to the same kiln. The nearest approach to this coal consumption met by him in practice was 71 lb., though unfortunately in that kiln combustion was not quite complete and the lining was old and thin. The average consumptions varied from 85 lb. for a 135-ft. kiln to 100 lb. and over for a 60-ft. kiln.

The author further states that reasonable possibilities mentioned in his paper show that the coal consumption should be:

Reactions	15.7 lb.
Chimney loss, 300 deg., perfect combustion..	8.0 lb.
Clinker loss, half heat regenerated.....	6.0 lb.
Radiation and conduction loss, composite lining	13.5 lb.
Total	43.2 lb.

NEW YORK CEMENT SHOW.

The time is rapidly approaching for the big cement gathering in New York in December (December 14-20.) The occasion will be the First Annual New York Cement Show in Madison Square Garden, the Seventh Annual Convention of the National Association of Cement Users and the Annual Convention of the Association of American Portland Cement Manufacturers.

The exhibition, which is being held under the management of the Cement Products Exhibition Co., 115 Adams St., Chicago, promises to be the most important Show yet held. This is the first venture of its kind in the east and is receiving the enthusiastic support of the two hundred and fifty exhibitors, who will make displays there.

A big advertising campaign has been outlined for the purpose of interesting cement users throughout the east and particularly in New York City, in the approaching Show. Two features of unusual popular interest will mark the New York Show. One is the appearance of John Philip Sousa and his Band, who have been engaged during the entire period of the Show. Concerts will be given each afternoon and evening. The other feature is the exhibit to be made by Mr. Thomas A. Edison. For the first time, Mr. Edison will make a public display of his scheme for pouring cement houses. While the press of the country has devoted much space to the discussion of Mr. Edison's invention, this is the first instance where Mr. Edison has personally exhibited his models at a Cement Show.

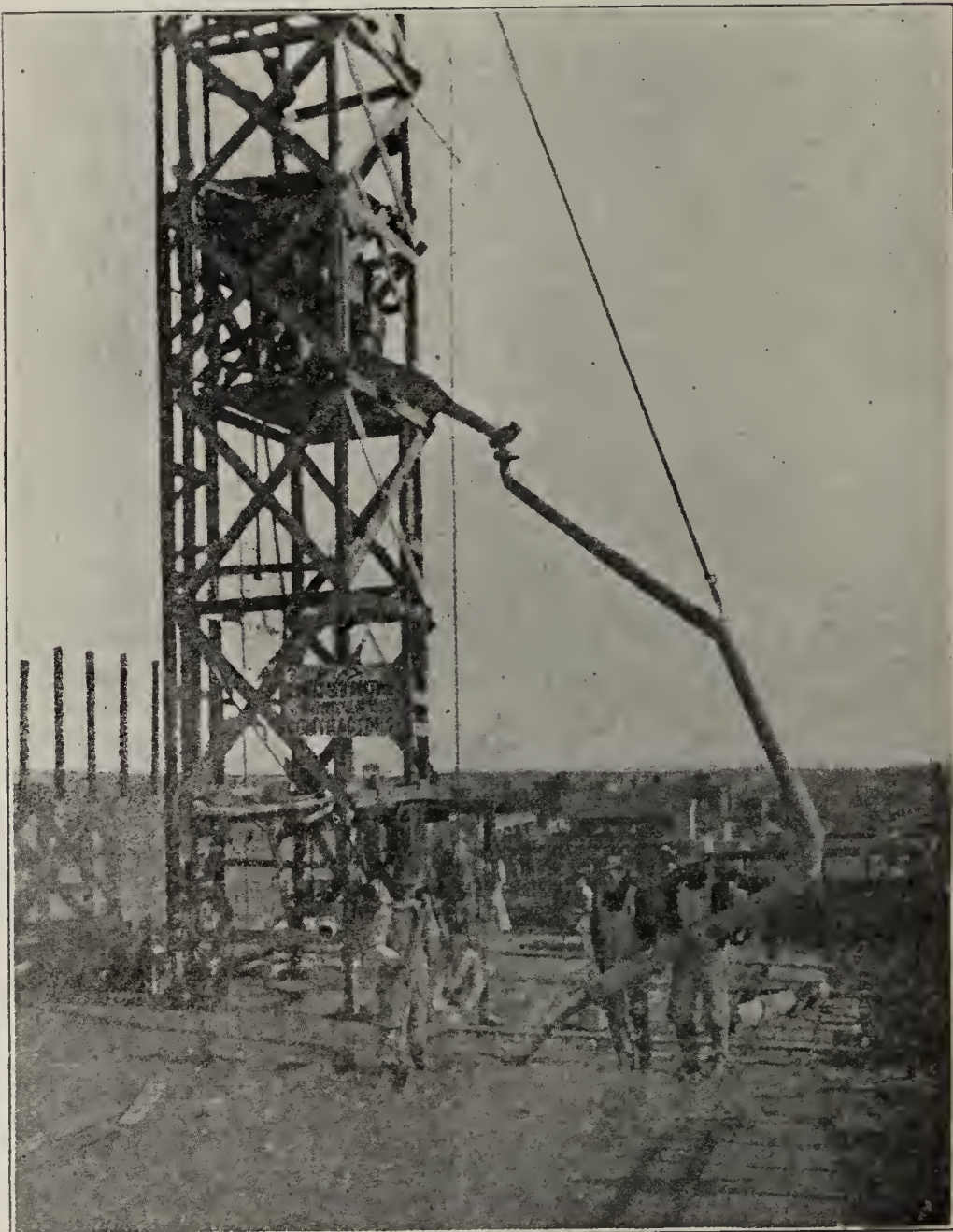
PLACING CONCRETE THROUGH METAL PIPES.

For some years F. O. Engstrum Company, contractors, Los Angeles, Cal., have been employing gravity methods of placing concrete in all sorts of structures and have constantly been improving their methods. As now utilized the general scheme adopted for all the installations consists in placing the concrete mixer on the ground with the sand and stone storage bins conveniently placed. The mixer discharges into an automatic dumping elevator bucket which is raised through a tower, at the top of which is a receiving box. Immediately below it is a second box, somewhat smaller, to the lower end of which a pipe is attached for delivering the concrete to place.

The pipes for distributing the concrete are of sheet metal 8 in. in diameter, and are made up in convenient lengths which can be quickly fastened together to form pipes of any length. The mixing and hoisting of the concrete to the receiving hopper at the top of the tower are timed to agree with the rate of discharge through the metal pipes, the object being to prevent the receiving hopper from being empty at any time. This allows

a steady flow to be maintained through the pipe and prevents its clogging. The concrete, of course, must be mixed quite wet, so that it will flow readily. The contractors have never found any difficulty in using the scheme for all classes of work.

The pipes being made of light material have but little strength to resist the bending due to the wet concrete and consequently must be supported at frequent intervals. Various methods are employed for this purpose, depending entirely upon the distance from the tower to which concrete must be delivered. In many cases this distance amounts to 100 ft. In the case of structures of small area it is often found sufficient to support the delivery pipe at one or two points by means of rope tackles having the upper blocks on the tower above the receiving hoppers.



POURING CONCRETE BY GRAVITY.
View of Tower and Pipe Line.

When larger areas must be covered it is found necessary to swing booms from the tower and to run supporting wires from different points on them to the discharge pipes.

A number of modifications of the last method have been adopted where conditions warranted the expenditure. For example in constructing the Timken Building, an eight-story office building in San Diego, the contractors used a boom of box section made with light corner angles connected by lattice bars. The cross-section of the boom was large enough to place the 8-in. pipe inside of it. It was about 50 ft. long, but could be utilized for any length of discharge pipe by simply taking off or adding pipe sections, the lattice bars being far enough apart to allow an elbow to be passed between them. This boom in itself did not have sufficient strength to carry the pipe filled with

concrete if supported at only one point, and consequently a shorter timber boom was swung above it and supporting wires were passed from the one to the other at short intervals. In the case of the Christian Science Temple at Pasadena, Cal., a still heavier trussed boom was used, but in this case the pipe was not passed through the center of it, but was hung below. This boom was strong enough to carry the weight of the pipe filled with concrete when supported only at its foot and middle. The pipe was hung beneath it by wires close enough to prevent the pipe bending.

When concrete is deposited so far from the tower that booms cannot be used, it becomes necessary to use intermediate timber supporting towers between which the concrete pipe is carried on the top of light timber trusses. A very elaborate plant of this description was erected by the contractors in building the State Normal School at San Jose. This building has two wings at right angles to the main structure, and with the wings is over 500 ft. long. In order to handle the job efficiently three independent concrete outfits were installed. Each consisted of a Ransome mixer, a Wallace Lindesmith elevator bucket working in a timber tower, and a number of intermediate supporting towers and metal delivery pipes. Two pipes were taken off from the bottom of the receiving hopper in each of these three towers and each diverging pipe was supported by either two or three intermediate towers. Each pipe, in turn, was divided into two branches, in this way covering the entire area.

In order that the pipe may be swung about freely it is necessary to place some type of swivel connection at the tower and also at a point near the ends of the pipe. Two essentially different styles of connections are employed. At the tower, as a rule, the first section of pipe is fitted with a trough-like end, above which is the discharging end of the vertical pipe from the box above. The trough is both long enough and wide enough to allow considerable freedom of movement without moving it from under the discharge pipe. At the lower end the swivel connection consists generally of a flanged end and a collar above it allowing the last section of pipe to be rotated through 360 deg.

As indications of the amount of concrete which can be placed by this system the following figures are quoted from the records of the F. O. Engstrum Company, at Colton, containing 6500 cu. yd. of concrete, runs of 250 cu. yd. were made in 8 hours, and on one of the precooling plants of the Southern Pacific Company, at Colton, containing 6500 cu. yd. of concrete, runs of 237 cu. yd. were made in 9 hours.

The contractors state that the system gives a very substantial saving in labor over depositing concrete by wheelbarrows or by carts, stating that they have reduced the cost of mixing and distributing to 15 to 25 cents per cubic yard, depending upon conditions. As a rule, only two men are required on the floor to handle each concrete pipe, and another man is placed in the tower above the receiving hopper. Another considerable saving, it is claimed, results from the elimination of the runways required in the cart and wheelbarrow systems, though, of course, the timber tower must be carried higher than with the other systems.

The system described has recently been patented by the Concrete Appliances Company, 405 Seaton Street, Los Angeles, and this company is now disposing of licenses for its use in all parts of the United States.

New York Cement Show December 14-20, 1910.

Chicago Cement Show February 17-23, 1911.

JEFFREY EXHIBIT, NEW YORK CEMENT SHOW.

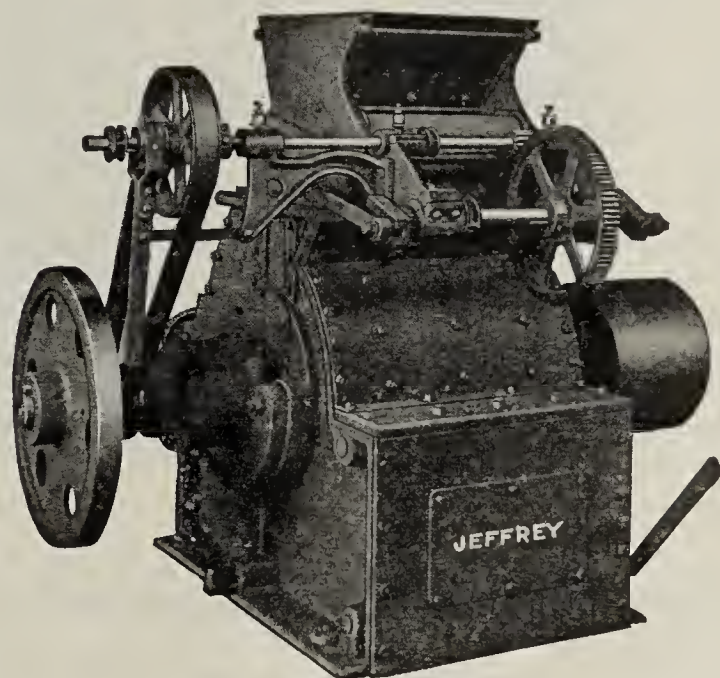
A very cordial invitation to visit the Jeffrey Exhibit is hereby extended to cement manufacturers attending the coming cement show that will be held in Madison Square Garden Dec., 14th to the 21st.

Elaborate arrangements are being made by the Jeffrey management to have on exhibition their latest types of Swing Hammer Pulverizers, which are being adapted for pulverizing cement rock and limestone.



Sectional View Jeffrey Type "B" Pulverizer.
Adjustable Breaker Plates. Dynamo Bearings.
For Reducing Cement Rock and Limestone.

This type of machine is an improvement over other types of pulverizers being provided with an ADJUSTABLE BREAKER PLATE made of Chilled White Iron or Manganese Steel, which is adjusted with a wrench to compensate wear on the hammers. This permits a uniform product to be maintained, and overcomes a serious objection to other pulverizers of this type.



Jeffrey Cement Pulverizer.

The screen bars are made of Tool Steel and the hammers of Manganese Steel. The machine is so designed that the material is broken in suspension so thoroughly that the bottom bars are only required to screen the product.

The machine is equipped with an automatic plate feeder for the reason that the material is delivered at a uniform rate and distributes same so that all the hammers are constantly employed.

Any refractory foreign substance, accidentally fed with the material may be easily removed through the Drop Bottom Cage without stopping the machine.

Ring oiling, ball and socket, bronze bushed bearings, of the highest type used as in dynamo service, are employed. These, experience has shown to be the most serviceable and to minimize the consumption of power.

Crushing tests of cement rock and limestone will also be on exhibition and manufacturers are invited to send their material to the Jeffrey Mfg.Co.'s Works at Columbus, O., where tests will be made and samples will be on exhibition at the cement show. These crushing tests are absolutely free.

PUZZUOLANA DEPOSITS.

The importance of possessing large deposits of suitable puzzuolana or tufa for the manufacture of lime-puzzuolana mortars or Portland cement-puzzuolana mixtures, to be used in irrigation work and marine construction, is now recognized by most countries. Governments as well as engineering societies and contracting firms are eagerly prospecting for this valuable building material, which at the same time reduces the cost of erection and protects the concrete against the corroding action of the salts dissolved in the water.

In the United States, the application of puzzuolana is a novel feature to most engineers; nevertheless, inquiries have brought out the fact that some of our engineers have not been slow in accepting advice from Europe and have made experiments on a large scale during the construction of the numerous irrigation works of the West. Thus, for instance, some tufa used in the construction of the Los Angeles Aqueduct are said to have given excellent results. The Pacific Coast seems to possess quite a variety of suitable puzzuolanas, which undoubtedly will be used extensively in the near future, as the enterprising contractors of the West make continuous inquiries as to the results obtained with one kind of puzzuolana or another and are anxious to make use of them, as soon as their cementing and waterproofing value is established beyond doubt.

In Europe, puzzuolana has been used on a large scale only in France, Germany and the Netherlands so far. Yet, also other countries are gradually realizing the benefits derived from its application and are going to use it in the construction of canals and harbor works. Russia, one of the largest builders, ordered its geological department to make exhaustive investigations during the last few years. The result was that in the Southern provinces of the country an abundance of puzzuolana of the proper composition was found, which proved to be as satisfactory as the famous volcanic products of Greece, Italy and Germany.

NEW JEFFREY CONVEYOR BOOKLETS.

The Jeffrey Manufacturing Company of Columbus, Ohio, have just issued booklet No. 28, on conveying machinery for handling stone, sand and gravel, and bulletin No. 42, describing coal handling and mining machinery. The former shows a number of plants of various sizes on different classes of work, and illustrates in detail the conveyors, elevators, screens and other machinery with which they are equipped. The Jeffrey electric storage battery industrial locomotive is also shown in this booklet.

The coal handling booklet shows a number of installations in connection with coal mines, breakers, washeries, coaling stations, etc., and shows in detail the various equipment which this company makes for use in coal mining and coal handling. These booklets will be sent upon application to the company.

NEW PRESIDENT OF COPLAY CO.

The directors of the Coplay Cement Manufacturing Company have elected I. W. Loeb, a Philadelphia financier, as president, to succeed William H. Harding, who resigned. It was decided to move the main office from Philadelphia to Coplay, Pa.

SOPER ENGINEERING COMPANY WILL RE-MODEL CEMENT PLANT AT CHELSEA, MICH.

N. S. Potter, Sr., and N. S. Potter, Jr., purchased at bankrupt sale, Aug. 13, 1910, the vertical kiln plant at Chelsea, Mich., built by White & Miller some five years ago, they will install two 8x120 feet rotary kilns with other modern machinery. The Soper Engineering Co., of Detroit, Mich., has the contract for the reconstruction. The completed mill will be thoroughly modern.

DANGER IN DRYING COAL.

The following extract is taken from the January issue of "Quarterly of the National Fire Protection Association," Hartford, Conn., Henry A. Fiske, Editor, regarding the hazards of coal drying. It is of great importance to every manufacturer of Portland Cement, and should be most carefully considered. The people of the United States are demanding more than ever before that more attention be given to the safety of men employed in handling coal products. It is a very serious matter for any man to have resting upon his shoulders the responsibility, either directly or indirectly, of the killing of his fellowmen.

"Under no circumstances is it recommended that the products of combustion be allowed to come in contact with the coal to be dried. Some recommend this and I am informed that quite a number of plants are thus arranged. Already there have been quite a number of accidents from this cause in which lives were lost.

A characteristic coal mill explosion (March 2, 1903—Editors.) in New Village, N. J., caused by the ignition of pulverized coal at the Edison plant, killed six men and burned five others, perhaps fatally, besides injuring a score of others and destroying the coal building. It is supposed that the pulverized coal in the bin fired spontaneously and some of the burning fuel was carried by the conveyor (automatic) into the blower house. The atmosphere of the blower house being charged with coal dust an explosion was the result.

On August 19, 1900, an explosion in the plant of the Nazareth Cement Co., Nazareth, Pa., caused a loss of \$16,000, while on November 26 of the same year \$40,000 damage was done to the Martin's Creek Portland Cement Co. (then known as William Krause & Sons), Martin's Creek, Pa. The Dexter Portland Cement Co., Nazareth, Pa., and the Alpha Portland Cement Mill No. 1, Alpha, N. J., had similar experiences the same year.

I learn that the laws of England do not allow any coal dryers where the products of fire come in contact with coal to be dried, and engineers in that country had already predicted trouble with disastrous results in this country before the above mentioned accidents occurred."

We have always advocated and practiced that the products of the fire should never come in contact with the coal dust while it is being dried on account of the liability of explosion. Can there be any better proof of this under high heavens than the above extract by Mr. Henry A. Fiske.

The coal driers manufactured by the C. O. Bartlett & Snow Co., Cleveland, Ohio, exclude all danger from explosion.

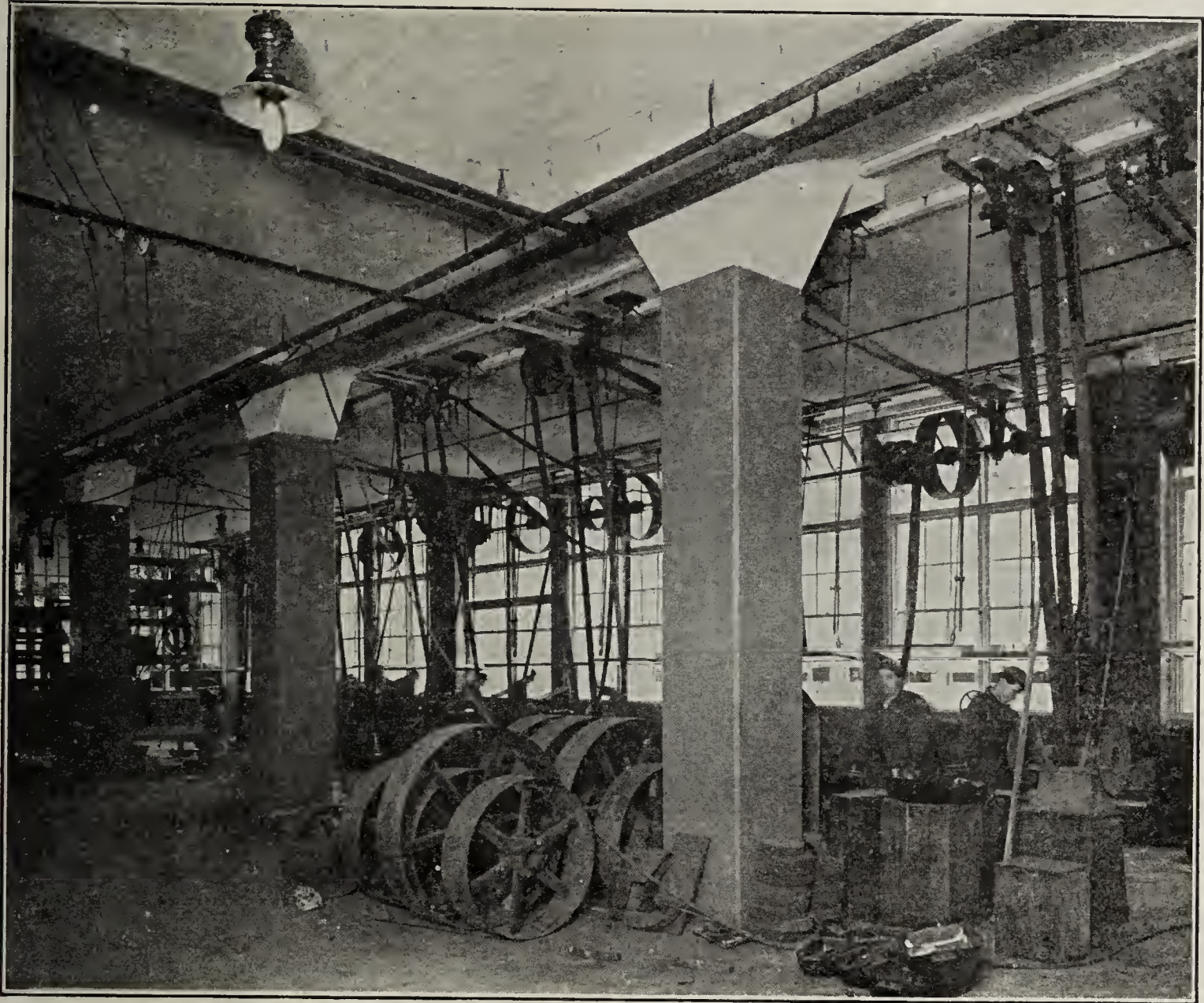
AN UNUSUAL COLUMN HEAD SUPPORTING A GIRDERLESS CONCRETE FLOOR.

An interesting problem arose in connection with the location of some shafting and piping in the new reinforced concrete Truck Assembly Building of the Pierce Arrow Motor Car Co., at Buffalo, N. Y. This building is designed with the girderless or mushroom type of reinforced concrete, the column heads begin to flare at a distance of 2 feet 3 inches below the bottom of the floor slab, the width at the floor slab being 4 feet, 10 inches.

The floor is designed to carry 150 pounds per square foot live load, the slab is 8 inches thick and the columns 20 feet, 6 inches on centers. Figuring the weight of the floor slab at 103 pounds per square foot, this means 106,323 pounds to be supported on the floor in one panel or 26580 pounds on each column for each story.

top of the cap from 3 inches which was the depth in the ordinary columns, to 5 inches giving in all a total depth of 13 inches at this point. To take care of the reverse bending, in addition to the regular slab steel consisting of $\frac{1}{2}$ inch round rods 6 inches C-C in each band of reinforcement, four one inch rods were placed across each column near the top of the floor slab running at right angles with the flare of the column. These rods were nine feet in length and extended out into the floor slab equal distances on either side of the column.

This arrangement was designed by Messrs. Lockwood, Greene & Co., of Boston, engineers and architects, for all of the new buildings at the Buffalo plant of the Pierce Arrow Motor Car Co., and was constructed by the Aberthaw Construction Co., also of Boston.



An Unusual Column Head Supporting a Girderless Concrete Floor.

In laying out the shafting it was found necessary to run a line close to the head of one row of columns and it was also desirable to run a line of pipe on the other side of this same line of columns close to the floor slab of the floor above. It was consequently necessary to so design this line of columns that the flare of the head to support the floor slab should not interfere with the shafting or piping.

This was accomplished by running the columns on two opposite sides, plumb up the under side of the square portion of the column head. The flare of the columns in the other directions acted in a measure as a cantilever beam supporting the square column cap, on which the floor slab of the story above would rest. There would consequently be developed a reverse bending moment over the column and at right angles to the flare which would tend to crack the floor slab at near its upper surface. The shear at the column was taken care of by increasing the depth of the square

REPUBLIC RUBBER COMPANY BUILDING LARGE ADDITIONS TO THEIR PLANT.

The Republic Rubber Company of Youngstown, Ohio, manufacturers of the famous Lanco Balata belting for cement mills, have under construction a new building, 250x90 feet, for manufacturing this belting. This new factory has been under the supervision of engineers from the British plant and will be the largest and most modern of its kind in the world. The belting will be made by the secret and exclusive processes used by the English company who have given the Republic Rubber Company the exclusive rights to their trademarks and processes, and to manufacture in this country.

The Republic company have also awarded the contract last week for another five story building, 80x200 feet, to be occupied when completed by their tire and hose departments.

CONCRETE WAREHOUSE OF ILLINOIS GLASS COMPANY.

The above view illustrates the new concrete skeleton case warehouse of the Illinois Glass Co., at Alton, Ill. The building was designed by T. C. Moorshead, Chief Engineer of the Company, and the concrete work was done by employees of the Company. The foundations, columns and second floor in the main building are of solid, reinforced concrete, the Kahn System and plain reinforcement being used. The curtain walls are of hollow tile plastered on the outside with cement. The floors were designed for a live load of 250 pounds per square foot.

The main building is 100 feet wide and 306 feet long, the height from the first floor line to the second floor line and from the second floor line to the bottom of the roof trusses being 10 feet in each case. The roof trusses span the entire width of the building, and are 16 feet in height at the center. There is a lean-to shed on the north side of the building 40 feet in width and running the entire length, the roof of which is carried on 40 foot trusses supported on brackets on the outside column of the main building, and by concrete columns on the outside.

On account of the fact that the first floor was to be used for the storage of bottles only, except 90 feet on the

and this work followed up with an 8 inch hollow tile curtain wall around the entire second floor, and panels below the second floor. The roof was covered with tar and gravel.

After the hollow tile walls had been constructed the entire outside of the building was plastered with a mixture composed of one part Portland Cement and two parts sand and painted with waterproofing concrete paint.

The entire building complete, including the heating for entire second floor and a space 90 feet by 100 feet on the first floor, with water and sewer connections and a freight elevator, cost 4.2 cents per cubic foot.

NEW SAND LIME BRICK COMPANY.

The Philadelphia Sand Lime Brick Company is the title of a new company which was recently incorporated at Camden, N. J. with a capital stock of \$100,000 to manufacture sand lime brick. The incorporators are F. R. Hansell, John A. MacPeak and J. C. Clow, all of Camden, N. J.



Concrete Warehouse of the Illinois Glass Co.

east end of the main building, it was left open up to a height of 10 feet between the columns and a concrete beam put in which acted as a brace and also carried the curtain wall above. This wall was built up of 6-inch hollow partition tile plastered with one-half inch coating of Cement plaster.

The second floor is a combination of reinforced concrete and hollow tile, 10 inch hollow partition tile being used, 17 inches on centers, leaving five inches of concrete between, and two inches of concrete on the top of the tile, making a floor thickness of 12 inches. These slabs were carried on "T" beams, 26 inch total depth and 20 foot span, the slabs being made for an 18 foot span and designed for a live load of 250 pounds per square foot. In constructing the building, forms were built for the entire skeleton frame and floor and the pouring of the concrete was started when the forms for about one half of the building had been completed. The usual method of handling concrete was used, a tower and a hoist being constructed in about the center of the main building and the concrete mixed on the ground and hoisted to a hopper above the second floor from which it was chuted and placed.

After the concrete had all been poured, the roof trusses which were carried on 10 foot columns, supported on the concrete columns at the second floor line, were erected

THE MOBILE CEMENT PLANT IS TO BE COMPLETED.

Francis L. Robbins, a widely known coal operator of Pittsburg, Pa., was elected president of the Alabama Cement and Coal company at a meeting of the directory in Mobile, Ala. the other day. Recently Col. E. L. Russell, vice president of the Mobile and Ohio Railway company, resigned the presidency of the cement company. Today he was elected vice president and Col. A. S. Lyons, who held that position, became a member of the board of directors. Mr. Robbins was formerly president of the Monongahela River Consolidated Coal and Coke company and the Pittsburg Coal company. The latter is acknowledged to be one of the largest individual coal operators in the Pittsburg district. His election means the immediate completion of a cement plant the company is erecting on its 17,000-acre tract of cement and clay land at St. Stephens, on the Bigbee river, which is to have a capacity of 1000 barrels a day.

It was announced also that the company would begin the development of more than 10,000 acres of coal lands which it owns on the upper Bigbee river, following the building of adequate wharfage facilities on the Mobile

river front and the inauguration of a line of barges between this city and the company's properties. President Robbins said tonight that the company expects to be operating both its coal and cement fields before the end of the year.

The company was organized in 1907 with a capitalization of \$6,000,000. Inability to secure clear titles to its land purchase from the state until recently prevented the beginning of operations sooner.

CONCRETE RAILROAD STATION.

Concrete is becoming universally recognized as being peculiarly adapted to the construction of railway stations, a use for which it is more and more being brought into requisition. The large number of dilapidated, unpainted, dirty, ill-smelling railway stations of the country may thus be done away with and replaced by structures which will be neat, attractive in appearance, clean and sanitary and absolutely fireproof.



Concrete Railroad Station, Waverly, Iowa.

The concrete station illustrated above was recently completed for the Chicago, Rock Island & Pacific Railroad at Waverly, Ia., and is a typical example of concrete construction, for, with the exception of the window sash, doors and door frames, there is not a stick of wood in the whole building. The station is 72 feet 6 inches long, and 35 feet wide in its widest part, and was constructed after the system invented by Geo. M. Graham and controlled by the Suspension Steel Concrete Co., Chicago. The architect was M. J. Morehouse, Chicago, and the construction was done by Kohler Bros. of the same city.

The system of construction is a combination of steel tubing, wire, malleable fittings, expanded metal and concrete. The frame work of the building is an entirely self-supporting structure of 4-inch steel tubing, which is bolted together with angle irons at the joints. This frame work rests on concrete piers or footings, and after it is erected is filled with concrete, which not only gives it additional strength but prevents corrosion on the interior of the pipe. The entire frame work may be erected before the concrete work is started, and thus the position and quality of the steel may be inspected. The walls and floors are hollow, which reduces the weight of the floors to the minimum and affords perfect insulation, and the strain on the floors is carried by wire in tension, which is one of the most

economical ways in which steel may be used. This system of wires is used for the walls, floors and roof which latter is also of concrete. For the floors and roof expanded metal is fastened to the wires, being placed beneath them and wired to them, thus insuring the embedding of the wires themselves in the concrete. The walls are made in the same way, the wires being strung on both sides of the tubing and the expanded metal fastened to the outside, thus providing a hollow space in the wall of at least 3 inches. The roof of the structure was given two coats of cement plaster, the last coat being tinted and floated off smooth. The outside walls were given three coats, the last being a pebbled dash coat left in the natural gray of the cement.

OKLAHOMA GYPSUM DEPOSITS.

Charles N. Gould, director of the Oklahoma Geological Survey, says:

No state in the Union has a larger supply of gypsum and Portland cement material than has Oklahoma. Ac-

cording to an estimate made a few years ago there are available in the western part of the state 133,000,000,000 tons of gypsum; enough to keep one hundred miles each manufacturing one hundred tons of plaster a day busy for thirty-four thousand years. No estimate has even been made of the amount of material available for the manufacture of Portland cement in the new state, nor is it probable that such an estimate can ever be made, for the reason that the amount of material is past computation. More than half the counties in the new state contain limestone and clay suitable for the manufacture of Portland cement and in quantities which are inexhaustible. To cite only a few examples of many that might be mentioned, nearly half of Murray county is covered with a ledge of limestone a mile thick, with clay near at hand in sufficient quantities for millions of barrels of cement.

A ledge of limestone five hundred feet thick extends from Wapanucksa past Atoka, Kiowa and Hartshorne, for over one hundred miles nearly to the Arkansas line, and besides this ledge all the way runs a bed of good clay and a vein of coal. The greater part of Ottawa, Delaware, Adair and Cherokee counties is covered with a limestone ledge three hundred feet thick underlaid with good clay.

In addition to the vast deposits of limestone and clay, Oklahoma has plenty of fuel for their manufacture.

According to the government estimate there are approximately 3,000,000,000 tons of coal segregated in the Choctaw nation. There probably is as much more not segregated in the Choctaw, Creek and Cherokee nations. The oil and gas deposits are said by those in a position to speak with authority to be the largest in the United States. All this coal and natural gas is available for the manufacture of gypsum plaster and Portland cement.

With the deposits of gypsum, limestone and shale, and fuel sufficient to manufacture it, there is no need to fear that Oklahoma will ever be lacking in building material. The world is passing out of the wood and iron age and into the cement age. Oklahoma has two cement mills, The Oklahoma Portland cement company at Ada, and Dewey Portland Company at Dewey, Okla, and will soon have another. The Choctaw Portland Cement Co is building a new plant at Hartshorne, Okla.

STATE NORMAL SCHOOL AT SAN JOSE.

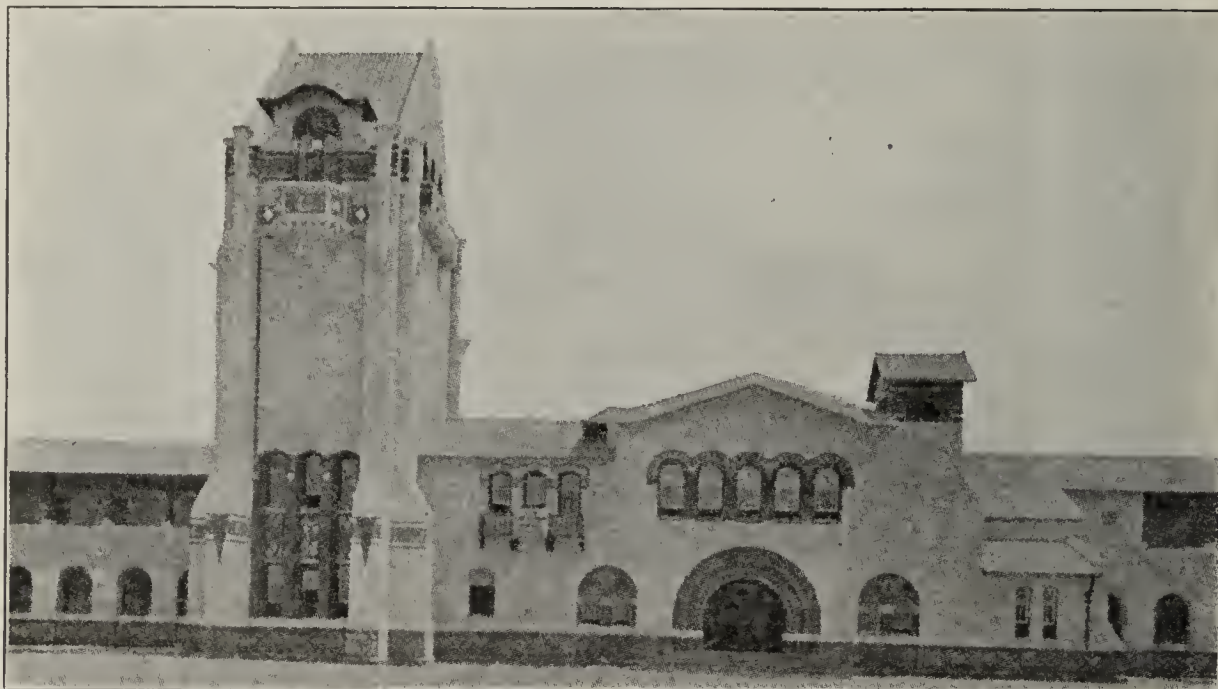
The California State Normal School, just completed at San Jose, is said to be the largest reinforced concrete school building, in ground area, in the world. Because of its immense proportions and unusual exterior treatment it is attracting world-wide attention.

The decorations of the structure are unique, and

It was the desire of the State authorities to have a school building that would be both fire and quake proof; at the same time the style of architecture was to be in keeping with the country and climate, and finally the structure must be made attractive. It must have color and life to it, outside as well as inside. That all this has been accomplished, one need only glance at the photograph illustrations to be convinced.

The building is built in the shape of a rectangle, broken up slightly with pavilions and buttresses. It is absolutely monolithic. The concrete was poured by gravity from three high towers, 43,840 sacks of cement being used in a mixture of one to six (three parts river gravel and three parts crushed stone.) The Lug bar was used for reinforcement, the tonnage amounting to something over 200 tons. besides 116,000 feet of wire fabric. More than 1,300,000 feet of lumber was used. This includes the cribbing, forms and interior finish. Forms were required for about 365,000 square feet of concrete. The exterior of the rough walls are covered with a pebble dash of Medusa white Portland cement. The interior of the corridors is treated with the stipple finish, while the interior of the building has the hard-wall sand finish.

The exterior color scheme is gray, red and green, red clay tile of a uniform size and color being used for the roof, which harmonizes nicely with the red brick and Faience tile inlays. The inlaid work is used



St. Jose State Normal School.

demonstrate the possibilities of ornamentation of all-concrete structures at comparatively small expense. Red pressed brick and Faience tile have been worked into simple, pleasing patterns to offset the monotony of somber, gray walls of concrete.

The building is the only one of its kind in California, if indeed, it has a duplicate anywhere in the world. It covers a ground area of 246 by 472 feet, and is two stories high. There is an imposing tower equivalent to five stories. The architecture is a combination of the so-called Mission and Spanish, with suggestions of the Moorish and Gothic, the latter being quite a little in evidence in the tower treatment.

From an artistic standpoint, nothing has thus far been developed in California to equal it. We are speaking now of a public building built entirely of reinforced concrete. The design was turned out by the State engineer and architect, Messrs. Nat Ellery and W. D. Coates, but the actual development of the plan was left to a young French student named Demarri, now in the employ of Architects D. H. Burnham & Co., of Chicago.

largely to decorate the entrances and towers. There are 20,076 square feet of inlay.

In the center of the building is a large quadrangle which will be laid out into concrete walks and grass plots. Extending entirely around the quadrangle, on both floors, are open arcades, affording comfortable passage from one classroom to another. The main vestibule floor is laid in Welsh quarry tile, while the corridor floors are of colored cement. All classroom floors, of concrete, are covered with 2¼-inch maple. The wood finish is Oregon pine, stained and polished. There are a total of 155 rooms, including all inclosures requiring both door and window. There are 38 large classrooms, the average size of which is 24 by 32 feet. The library is the largest room in the building, and is a gem in itself. It is two stories high, 60 by 97 feet, and void of columns to obstruct valuable space and light. The ceiling is done in ornamental plaster, with panels and Corinthian pilasters in staff and stucco. There are accommodations for 40,000 volumes, the equipment including 22 double steel stacks, each one 14 feet long, and 44 reading tables.

Special attention has been given to the lighting features of the building, the light invariably falling over the left shoulder. The building is fully equipped with gas and electric lighting facilities for use on dark days or at night. Every room has a private telephone connection. The building is heated by the plenum fan and exhaust system, the steam being generated in a boiler plant built some distance away. The heat is brought into the main building through a concrete tunnel, and is then distributed into the several rooms in galvanized iron ducts.

Erected at a total cost to the State of \$272,000, or a little less than 16½ cents per cubic foot, the building is unquestionably the best bargain California has ever been fortunate enough to make. The F. O. Engstrum Company has built many public structures in the past four years, but none quite as good as the Normal School for the money. Keen competition, of course, had a good deal to do with the low figure; likewise a desire on the part of the successful contractors to make it their banner job. Construction work covered a period of little more than a year, and was conducted under the personal supervision of Mr. F. O. Engstrum, president of the company.

FAN BLASTIN CEMENT BURNING.

By Max F. Mangelsdorff, B. SC.

The air blast in the burning of cement plays one of the most important parts in its manufacture, although very little has been written about this most important subject.

The blast employed at present in most cement plants is either in the form of compressed air, or that delivered from a rotary fan. Some manufacturers claim that compressed air is the best to use, while others believe that the fan blast gives them the best results. Without any doubt the fan blast is the cheaper of the two; however, either blast must be of sufficient force to blow the pulverized fuel into the kiln.

The air from either of these sources carries the small particles of pulverized fuel through a pipe and into the kiln, where they are ignited, creating a very intense flame by rapid combustion, so much so, that it has been found impracticable to direct this flame other than axially into the kiln, thereby burning the material by a heat radiating flame, instead of by the more effective impinging flame, which is used in the iron, steel, glass and other industries, where an intense heat is required right on the material.

Many experiments have been made in the endeavor to use the impinging flame in the manufacture of cement, but up to the present date all have failed, excepting the Combustion Utilities Company, which is a pioneer of the true impinging flame.

Most all the cement manufacturers realize that the hottest part of the flame is at its center when pulverized fuel was entered into the kiln through a round pipe, and with this knowledge in view they directed it onto the material, and found that it would burn the material faster than when the flame was directed axially, but it would also burn the lining of the kiln very rapidly, so that they had to finally abandon this impinging flame and go back to the more costly and wasteful axial flame.

The Combustion Utilities Company, as stated above, is a pioneer in burning cement successfully with the impinging flame, as with its method they can moderate the temperature to such a degree as to prevent the burning of linings, at the same time burning the

material very rapidly and permitting a considerable portion of the flame to help in the calcining of the material, making this more susceptible to the action of the sintering flame.

It is evident from this that a medium different from fresh air has been employed to bring about such a marked and much desired result; this medium practically consists in carbon dioxide. The method employed is to bring the products of combustion taken from the stack and to mix them with the proper proportion of fresh air; this mixture is then drawn into an exhauster and forced through the fuel nozzle and into the kiln. With this air-gas mixture a long or short flame may be produced which can be moderated in its intensity, as stated above, at the will of the burner, but this flame, as used by the Combustion Utilities Company, differs in the additional respect that it is a flat flame; furthermore, the nozzle, to produce this flame, is placed on the opposite side of the material, and is of such a construction as to produce two distinct angles of impingement. The direction of the flame produced by this nozzle near the hood is at an angle of about 45 degrees, while the outer portion of this flame is at an angle of about 60 degrees in relation to the hood, the total flame covering an impinging area of about 25 feet, imparting its intense heat directly to the material. It has also been found a positive preventative of the troublesome cement "ring."

It is well known where rapid combustion takes place, such as with straight air and pulverized fuel, that the material back of this intensely heated flame in the long rotary kiln must depend upon the heat of this combustion to drive off the carbon dioxide contained in the material, also that the temperature reduces very rapidly, due to the heat absorbing action of the material in giving off its carbon dioxide, and in that there are no sustaining properties in the heat developed by this rapid combustion.

On the other hand, if combustion were prolonged it would naturally create a longer flame, and the flame being a mass of intensely heated combustible gas, would naturally have a greater calcining effect on the material in the kiln, driving off a larger portion of carbon dioxide from the material and rendering it easier for clinkering. It is evident from this that with the use of products of combustion properly proportioned, and a properly designed nozzle, a greater output is possible, as well as a decreased coal consumption, for all of the energy in the coal is being used over a greater area.

One of the reasons why the linings of the cement kiln are not destroyed more rapidly where straight air and an axial flame are used is due to the fact that air is being drawn in in the front of the kiln by the stack, this air clinging to the inner surface of the kiln, and acting as an envelope to this intense round flame.

With the flat nozzle all the air for complete combustion is entered through the nozzle, while in the ordinary system only a small proportion of the actual air required is entered, this ranging from 30 to 40 per cent in most plants.

A little explanation on this point may be needful. The majority of plants using fan blast operate under a pressure varying between four to eight ounces per square inch. The opening of the conical shaped nozzle in the fuel feeding apparatus is generally from 2½ to 4 inches; the larger the opening, the lower the pressure. Now, under 4 ounces of pressure there can only be discharged through one square inch of effective area 71 cubic feet of air, while under 8 ounces pressure 100 cubic feet of air may be discharged through one square inch of effective area.

Taking for example a plant using 100 pounds of coal per barrel of cement and turning out 8 barrels per hour, it will take 800 pounds of coal per hour, or 13 3-10 pounds per minute, and assuming 150 cubic feet of air per pound of coal used, we would then need 1,995 cubic feet of air per minute.

As stated above, most nozzles under high pressure are about 2½ to 3 inches. Taking for example a 3-inch pipe, the area of which is 7 inches, and assuming this to operate under 8 ounces, it is evident that we can only discharge 700 cubic feet of air, or a little over one-third of the air actually needed; even assuming this nozzle to be a 4-inch opening, operating under 8-ounce pressure, we could only discharge 1,250 cubic feet of air, not allowing for the loss in friction, which would be at least 10 per cent.

With the Combustion Utilities Company's flat nozzle a double piping system is used, one set supplying most of the air for combustion, and the other set being simply used as a means of forcing the pulverized fuel into the kiln, the two together supplying sufficient air for complete combustion.

THE ARIZONA CEMENT CO.

The Arizona Portland Cement company, the company which purchased the machinery of the United States government cement plant at Roosevelt a few days ago and which has control of deposits for making cement near Winkelman, Ariz., has opened an office in suite 415 Fleming building, Phoenix, Ariz., where it is directing its financial campaign. The company's chief chemist is Paul F. Bovard, who was connected with the government's cement plant at the Salt River valley irrigation project, and F. L. Tupper is engineer in charge of construction.

CONCRETE FOR ELEVATOR FOUNDATIONS.

In a recent number of the *Modern Miller* the following significant article on the use of concrete foundations for grain elevators was published. Its significance will be the more apparent when the enormous loads which modern elevators carry are taken into consideration.

There are few millers who will not incline their ear to a discussion of proper construction of concrete storage tanks. Some recent foundation work for such elevators has stimulated discussion because fundamentally opposite in principle. In one recent case a milling firm chose as a foundation for four tanks a concrete quadrangle three feet thick extending three feet beyond the perimeter of the quadrangle. This concrete foundation was set on soft ground and when the elevators were filled showed no signs of settling. Another foundation was concrete placed over piling and the base did not extend outside the wall lines. In this case the elevators showed such an alarming tendency to settle that houses adjoining were vacated. The question discussed is the value of piling as means to carry a load. In this case its efficiency is doubted and the "snow shoe" scheme of making the one-piece foundation with greater area than the base of all the elevators is preferred by those who studied the merits of such construction.

This is merely an expression of opinion from practical men, and builders evidently have some conflicting views about foundations to carry heavy loads. Those contemplating elevator construction, other than the reliable steel storage tanks of moderate capacity, will no doubt be interested in some recent results of building big concrete tanks without going to rock.

ORENSTEIN-ARTHUR KOPPEL COMPANY

PITTSBURGH,
PA.

BRANCH OFFICES:

New York Chicago Baltimore
Philadelphia Boston
San Francisco
Denver

"MESSRS. ARTHUR
KOPPEL COMPANY,
PITTSBURGH, PA.

We are in receipt of your letter of September 10th, regarding the small Dump Cars which we purchased from you last Fall. We were somewhat skeptical at first about the adaptability of these cars to use on our concrete work. Now we feel that they are the main spring of our concrete plant. With their use, we are able to get the maximum output of the mixer."

Great Lakes Construction Company,

(Signed) D'ARCY W. ROPER, Secretary.

BOOK NOTES.

MODERN Manufacture of Portland Cement is the title of a new book published by the Mc Graw-Hill Book Co. Its author, Percy C. H. West, describes in an exhaustive and interesting manner the numerous types of kilns, grinding mills, conveyors, elevators, driers, coolers and other apparatus used at cement plants and intends to give in a second volume the theoretical side of the subject as well as a description of the laboratory work accompanying the process of manufacture. If complete, the series of books will present the theory and practice of cement burning in a fascinating form and will be a handy reference-book for the manufacturer as well as the student.

This first volume covering the **Machinery and Kilns** is especially interesting for the reason that it does not deal exclusively with machinery of American workmanship, but that it describes and illustrates foreign kilns and installations as well. It is concise and up-to-date, and deserves to be recommended. 250 pages. Handsomely bound \$4.00.

HENDRICK'S COMMERCIAL REGISTER.

The 19th annual revised edition of Hendrick's Commercial Register of the United States for buyers and sellers has just been issued. It is by far the most complete edition of this work so far published. The total number of classifications in the book is 35,481, each representing some machine, tool, specialty or material required in the architectural, engineering, mechanical, electrical, railroad, mine and kindred industries, the whole representing upwards of 350,000 names and addresses.

The value of the Commercial Register for purchasing purposes is not confined to its complete classifications alone, it also gives much information following the names of thousands of firms that is of great assistance to the buyer, and saves the expense of writing to a number of firms for the particular article required. It also includes the trade names of all articles classified in the book so far as they can be secured. These trade names appear in parenthesis between the names and addresses under the classification where they appear. The book is revised, improved and issued annually and has been since 1891. It is expressed to any part of the country on receipt of ten dollars. S. E. Hendricks Co., publishers, 74 Lafayette street, New York.

NEW CRUSHED STONE PLANT.

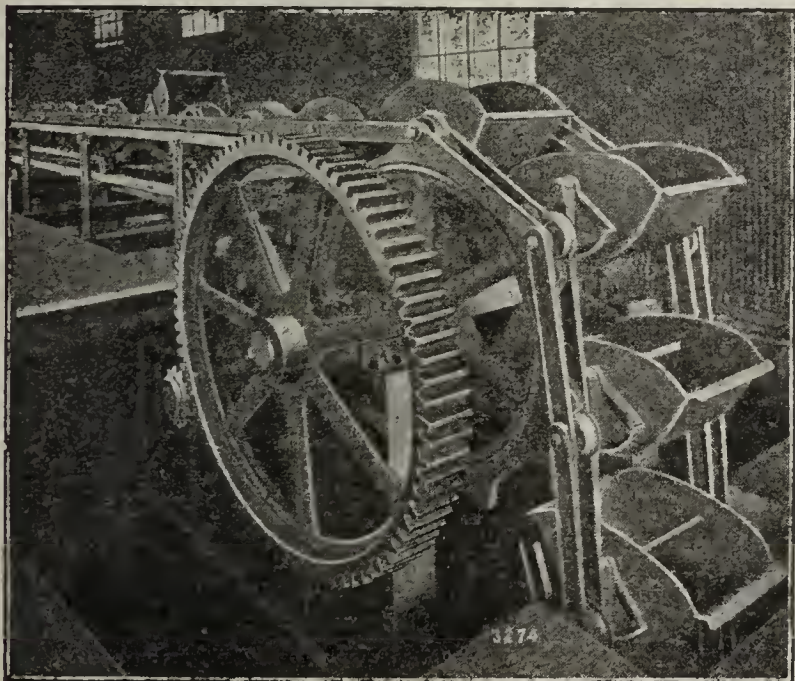
Engineers J. C. Buckbee & Co., 164 Dearborn St., Chicago, Ill., are preparing plans for a plant for the United States Crushed Stone Company Chicago. Will require traveling cranes, conveying machinery and a number of small motors.

TIDEWATER CEMENT MILL.

The Wisconsin Engine Company, Corliss, Wis., have recently received a contract for three (3) Horizontal Cross Compound Condensing Corliss Engines for the Tidewater Portland Cement Co., at Union Bridge, Md. Size of each engine 23 & 46x48", direct connected to a 925 K. V. A., 3 phase, 60 cycle Alternator. These engines will be furnished with a special valve gear, cylinders and governors peculiar to the "Higher Speed" Corliss Engines built by the Wisconsin Engine Co. They will be designed for particularly economical performance and close regulation on a variable load.

PECK CARRIER

a conveyor-elevator consisting of malleable iron buckets (that overlap on the horizontal runs) attached to roller chains.



Descending turn of PECK CARRIER showing bucket on horizontal run tilted into emptying position.

The corner turns are made around wheels—just a simple change from one run to another without interfering with the natural carrying position of the buckets.

For rules of correct conveying, as well as descriptions and views of various installations, see our Book No. 81. Address nearest Office.

LINK-BELT COMPANY
PHILADELPHIA **CHICAGO** **INDIANAPOLIS**
 NEW YORK, 299 Broadway
 PITTSBURGH, 1501-2 Park Building
 ST. LOUIS, Central National Bank Bldg.
 SEATTLE, 439-440 New York Block
 DENVER, Lindrooth, Shubart & Co.
 NEW ORLEANS, Wilmot Mch. Co.
 SAN FRANCISCO, Eby Machinery Co.

ATTACHING SHAFTING AND MACHINERY IN REINFORCED CONCRETE BUILDINGS

By W. M. Bailey.

The manner of attaching shaft-hangers, pipes and machinery to beams and floors in a factory or mill building of the reinforced concrete type is a detail of considerable importance, so much so, in fact, that often, if no satisfactory scheme is explained to the owner, he will not consider the use of reinforced concrete beams in his proposed building. In the ordinary mill-constructed factory, with wooden or steel floor beams, there is no special difficulty in attaching hangers for shafting and pipes for fastening machinery to the beams and floors in any desired location without any previous plans necessary and at a minimum cost, but in a concrete building the conditions are entirely different, and it is much better to adopt some scheme for the installation of the machinery, piping, etc., before the building is constructed if we wish to obtain the best results in all respects.

Appliances for conveniently supporting hangers for pipes and shafting and for supporting motors and other machinery from the beams and ceilings probably require more previous planning and careful selection than is necessary for other phases of this subject. The method recommended by the engineer and adopted for use with this type of building should be one designed to best meet all the requirements so far as can be known of the building and its later equipment. It should be inexpensive, compact and simple in form, with not too many separate parts, and as flexible as possible, to accommodate future changes in the line of shafting, additions or improved machinery, etc.

One of the most common methods employed is to attach a hard pine timber to the under side of the concrete beam. This may be in any desired length, to which the shaft-hangers are bolted or lag-screwed in their exact position. The timber can be secured to the bottom of the beams by bolts built into the concrete about four feet on centres, projecting a threaded end and nut below, or by use of sockets, inserts, sleeves and washer nuts embedded in the concrete, into which the timber pieces are afterwards fastened. If the bolts are used, care should be taken to set and keep them vertical; also have them thoroughly anchored into the upper part of the beams.

When a bolt is used through a beam near the top, a metal sleeve with a wooden core is concreted around to form the hole. These openings also permit the passage of pipes and wires. Large holes left in certain parts of beams and girders might cause weakness in the compressive side of the member. If so, an iron pipe sleeve of sufficient thickness should be used. It is rather difficult to always locate these holes through the beams during construction to conform exactly with future changes. Therefore, the system using the hooked hangerbolt in the side of the beam is more satisfactory, and is the one adopted for use in the Gair Publishing Company's building, Brooklyn. If the holes for the hook bolts are cut with a pneumatic drill it can be done at a nominal cost.

Blocks of wood are often set in the under side of concrete slabs to which are fastened wires and small-sized pipes and wire conduits. This is not considered a suitable or permanent support. It is much better practice to use either expansion bolts or locate and place adjustable sockets and inserts in the concrete work. Often the conduits for wires are placed on the centering and embedded in the concrete slabs. If the pipes are not too large and are located with due regard to the reinforcing metal, there is no serious objec-

tion to this method. Piping for sprinklers is generally planned before the concrete work is started. It is, therefore, a simple matter to place inserts or sockets where needed in the concrete work, to which the pipes can be readily attached later on.

Large machines with heavy bases sitting on the floor seldom require any special fastenings. It is usually sufficient to thoroughly grout with Portland cement mortar the base of the machines to the concrete by expansion bolts or similar methods after the floors are concreted, the cost of drilling for these fastenings being a small item of expense. Sometimes, however, it may be necessary to bolt through the floor in order to hold certain machines rigidly. If through bolts are required, the holes should, if possible, be located before the floor is concreted; otherwise, in cutting these holes through the floor reinforcing bars are liable to be encountered, which would cause more or less difficulty and might lead to serious trouble if cut off. In most cases machinery runs better and lasts longer if placed on solid foundations, and reinforced concrete floors are admirably adapted for machine shops. There are, however, exceptional cases where machines seem to require more or less give on their bases in order to be most satisfactory in working and endurance. This is particularly true with certain textile machinery, and where a cushion is required a wood-finished floor can be laid or wooden timbers or bolsters can be fastened to the concrete flooring. It has also been suggested to use sheet cork or linoleum carpet under the base of machines in order to give elasticity of movement and also lessen the noise of running machinery.

POWER FOR CEMENT MILLS FROM WASTE HEAT.

"Power for Cement Mills from Waste Heat" is the title of a booklet recently published by The Green Fuel Economizer Co., of Matteawan, N. Y. After presenting information regarding the amounts of fuel used in the various cement-making processes, it points out that a large per cent of the heat developed is wasted up the kiln stacks and boiler stacks, or radiated by the hot clinker. It then discusses several means of cutting down these wastes. The methods described include the use of an economizer in the kiln flue, combination of a boiler and economizer using the waste heat from the kilns and a method in which both a boiler and an economizer are used to absorb the waste heat, with a supplementary coal burning grate. A method is also described for preserving the heat which is usually wasted by hot clinker. These various methods of conserving the heat are illustrated by photographs and lay-outs of actual installations in cement mills. The same methods, with slight modifications, possibly, should be applicable in other industries where heat is wasted in considerable quantities, as from reheating furnaces, crucible furnaces, etc. Copies of this bulletin can be had by addressing The Green Fuel Economizer Co.

ATLAS CEMENT CO.

Mr. John R. Morron of Chicago, who has been President of Peter Cooper's Glue Company, has been elected President of The Atlas Portland Cement Company in the place of Mr. J. Rogers Maxwell who resigned on account of ill health. The change becomes effective November 1, 1910. Mr. Morron was selected for the Presidency by Messrs. J. P. Morgan & Co., who have lately become interested in The Atlas Company. Mr. Maxwell has been elected Chairman of the Board.

LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GROUND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.
ALLENTOWN, PA.

Western Office:
725 ROCKEFELLER BUILDING,
CLEVELAND, OHIO.



Jeffrey "Type B" Pulverizer



is superior in design and construction over other Machines made for reducing Phosphate Rock.

We also build this pulverizer in portable styles for reducing raw limestone for agricultural purposes.

It has a large capacity and yields a more uniformly fine product, consumes less horse power per ton of capacity and costs less for up-keep than any other machine of its kind.

Free crushing tests. Our new catalog Aa31 contains illustrations and full descriptions. Write for copy today.

THE JEFFREY MFG. CO., Columbus, Ohio.

"Visit Jeffrey Exhibit New York Cement Show"

ALPHA PORTLAND CEMENT....

Alpha, N. J.
Works: Martins Creek, Pa.
Manheim, W. Va.
Alsens, N. Y.

Quality unexcelled The Recognized Standard American Brand Always Uniform

ALPHA PORTLAND CEMENT CO.

Manufacturers of but one grade—strictly straight Portland
General Office, EASTON, PA.

Humane Double - Action Trowel

1. Finishes both ways.
2. Does as much work in two hours as a man can do in ten hours the old way, and does it BETTER.
3. Write for prices and literature. Use coupon, postal or letter and address nearest office below.

The Humane Horse Collar Co.

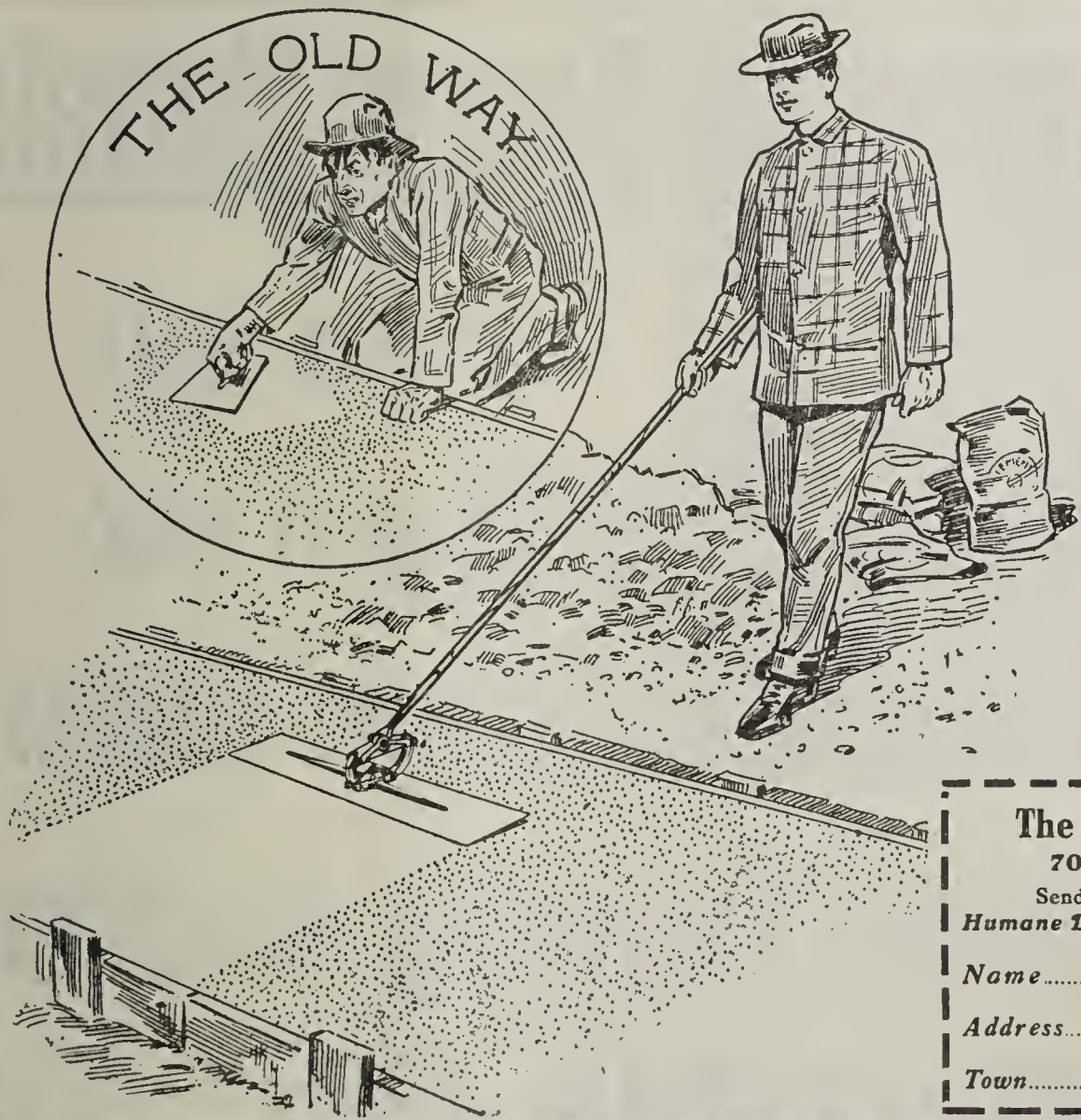
702 Lowe St., Chicago Heights, Ill.

Send me price and all literature on your new
Humane Double-Action Trowel.

Name.....

Address.....

Town..... State.....



Peerless Portland Cement

MANUFACTURED AT UNION
CITY, MICH.

Every Barrel Guaranteed

Fineness, Uniformity of Color
and Sand Carrying Qualities
equal to any Portland Ce-
ment Manufactured



TRADE MARK

PENINSULAR PORTLAND CEMENT

Acknowledged by competent Architects and Engineers
to be unequalled for fineness, wonderful development
of strength and sand carrying capacity.

"THE BEST IS THE CHEAPEST"

Address

Peninsular Portland Cement Co.
JACKSON, MICHIGAN.

Improved Canvas Stitched Belting



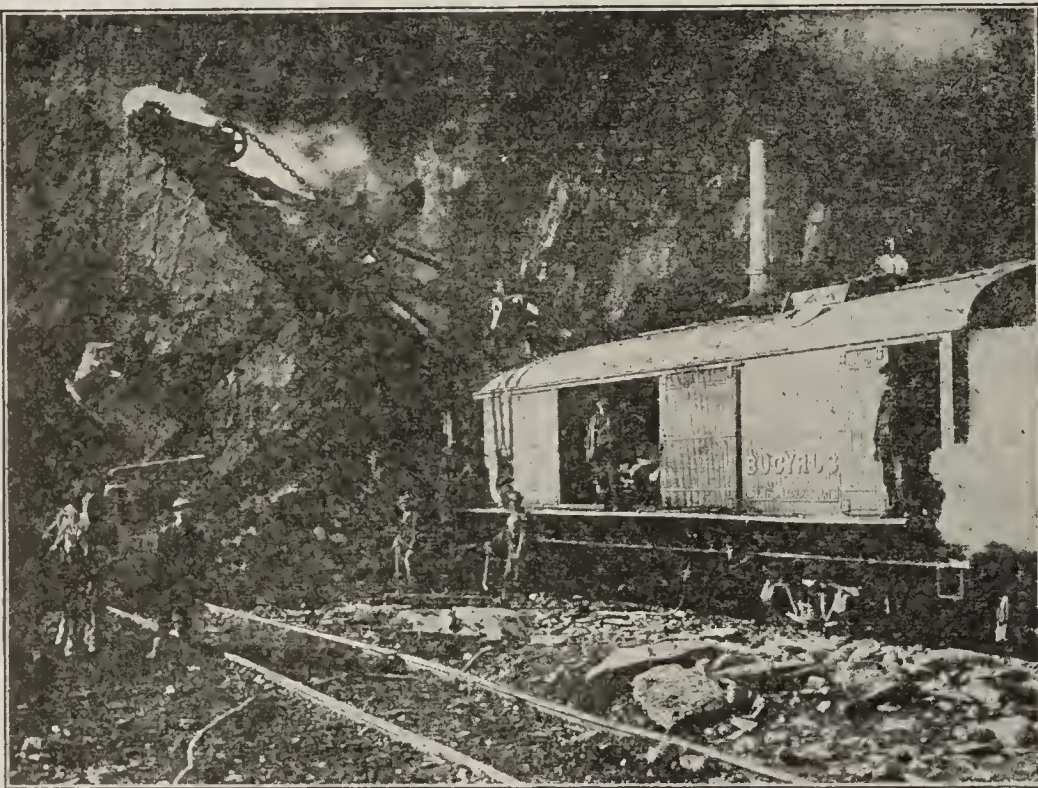
We Specialize in making Belts
for use in Cement Plants.

Light or Heavy Transmission,
Elevator or Conveyor Belts for
Wet, Dry, Hot or Rough condi-
tions.

Sawyer Belting Co.

Cleveland, O.

Send for Book "K."



95-B Bucyrus Steam Shovel in Cement Rock

Steam Shovels

FOR

DIGGING SHALE

AND

CEMENT ROCK

ALSO

STRIPPING QUARRIES

Dredges and General Excavating Machinery

THE BUCYRUS CO.

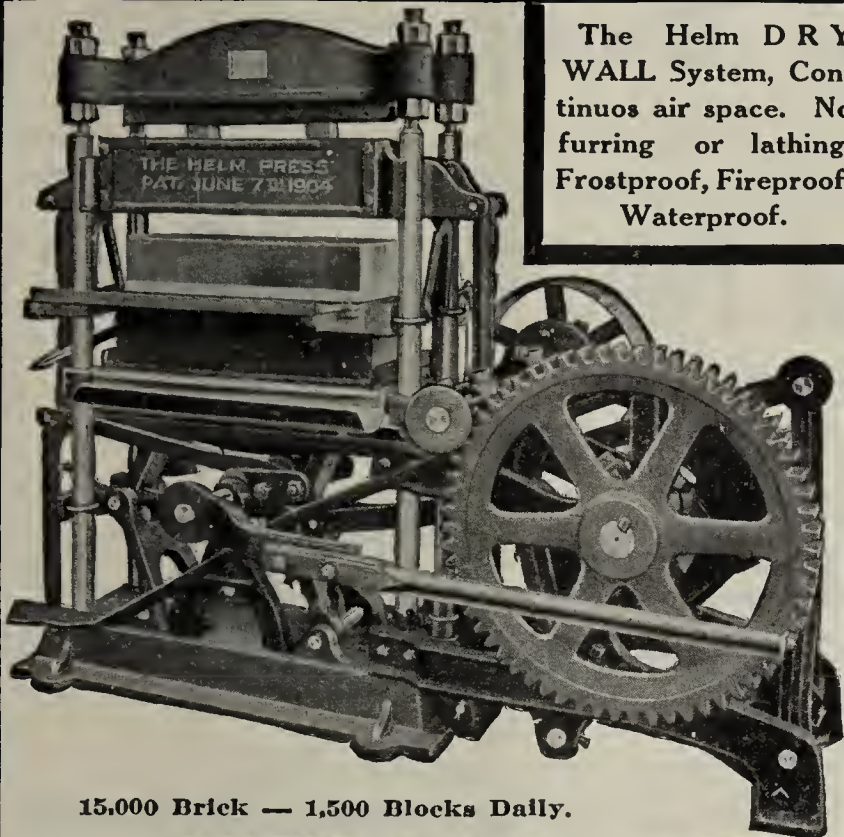
SOUTH MILWAUKEE, WIS.

BIG MONEY FOR YOU

In Pressed DRY-WALL Blocks and Brick

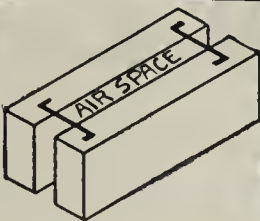
Helm Presses make as high as \$50.00 daily. You can secure the cream of the concrete business with their superior product. Unequalled for beauty, strength, adaptability and cheapness. Daily displacing machines of every description.

The 80,000 lbs. pressure of Helm Brick and Block Presses make the strongest and most uniform concrete product. A 6 to 1 brick only 27 days old stood 85,000 pounds compression, for excelling all other tests. Heavy pressure on medium wet concrete secures this wonderful result with the least cement. A Helm Press and the medium wet mix is the only sure and certain method. You're bound to adopt it in the end. You'll save money by adopting it now. No "extras" to buy with Helm outfits.

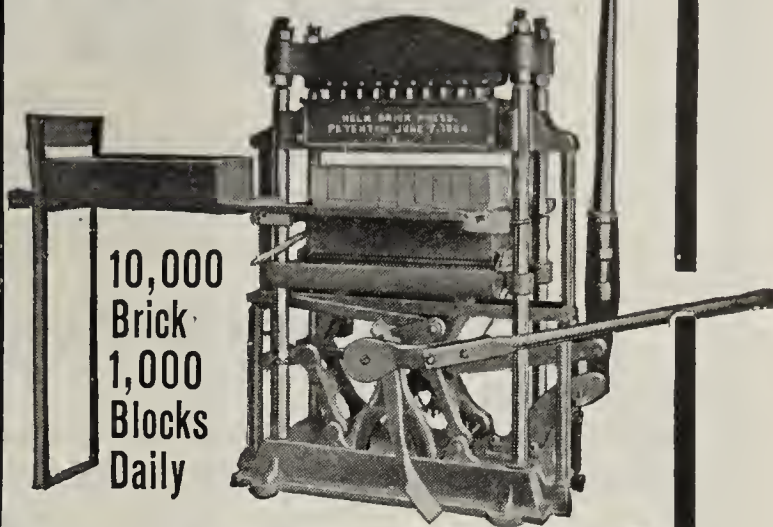


15,000 Brick — 1,500 Blocks Daily.

The Helm DRY WALL System, Continuous air space. No furring or lathing. Frostproof, Fireproof, Waterproof.



80,000 lbs.
Pressure



10,000
Brick
1,000
Blocks
Daily

Investigate the Helm Hand and Power Presses

if you want to control the big contracts in your locality. You can outstrip competition. You can manufacture cheaper, make better product and get better prices and more business.

Send the Coupon for free Concrete Book

Profusely illustrated with half-tones and diagrams of machines, product and building forms. Shows how to secure dry walls. Don't buy without first getting this book. Send the coupon right now for your copy, free and prepaid.

HELM BRICK MACHINE COMPANY,
214 Bank Building, Traverse City, Mich.

HELM BRICK MACHINE COMPANY,
214 Bank Bldg., Traverse City, Mich.

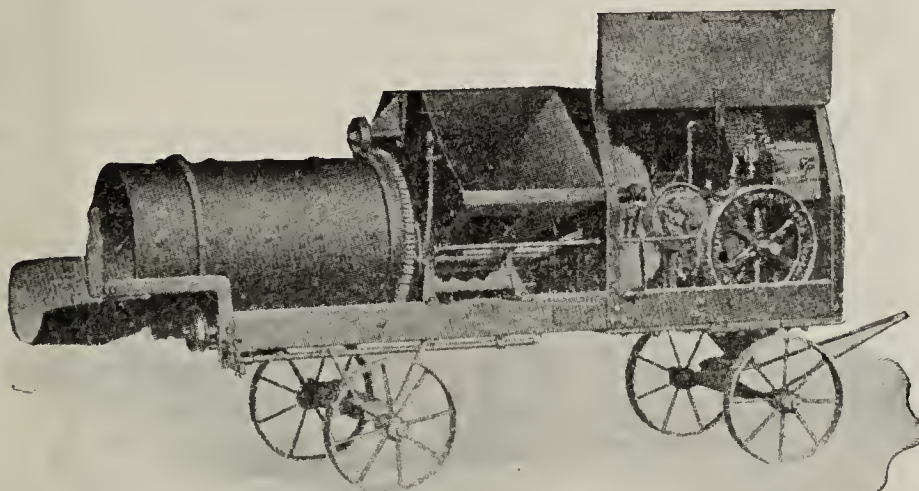
Send me the free book on concrete. Interested in ☐ Blocks, ☐ Brick. ☐ Mixers. ☐

NAME

ADDRESS

NATIONAL CONCRETE MIXER

**BUILT RIGHT—RUNS RIGHT—PROPORTIONS RIGHT—MIXES RIGHT
THEREFORE IS THE RIGHT ONE FOR YOU TO BUY**



The National does not depend on worms, paddles, spirals, sprockets, or chains to feed, mix, or run, but has an entirely new principle which has proven unbreakable, and that is what counts.

All iron and steel construction.

Has three hoppers located handy to get at. Application of water in plain sight and under perfect control. Will not break, therefore will not break you buying repairs. See the National at Cement Show, booth No. 264, or send for a catalog.

NATIONAL MIXER CO., 408 Powers Building, Rochester, N. Y.

IT WILL PAY YOU TO USE CROWN HYDRATE

(HIGH CALCIUM HYDRATED LIME)

For Waterproofing and Concrete

It Improves Its Strength and Color. Ask the

Marblehead Lime Company

KANSAS CITY

CHICAGO

Do you Know
that 

Bates Waterproof Paper Valve Bags

ABSOLUTELY PROTECT CEMENT ?

They Cost no more than the old absorbent Paper Bags

When Ordering Cement Ask for It in **WATERPROOF BAGS**

Bates Valve Bag Co.
5100 Lake Ave, CHICAGO.

Urschel Bates Valve Bag Co.
TOLEDO OHIO.

West Jersey Bag Co.
CAMDEN, N. J.

Location for Cement Plant

Extensive Deposits of Raw Material. Proximity to Large and Growing Markets. Low-Priced Fuel Supply.



THERE ARE several desirable locations for Portland Cement Plants along the Santa Fe, where the advantages enumerated are to be found. If you are interested you can secure full and detailed information by addressing this office.

The SANTA FE is glad at all times to co-operate with those seeking locations or desirous of investigating conditions in territory tributary to its line. Correspondence from interested manufacturers is invited.

WESLEY MERRITT, Industrial Commissioner A., T. & S. F. Ry.
1122 Railway Exchange Building CHICAGO, ILL

Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - - 645 No. Sixth St., Terre Haute, Ind.

RAILS! RAILS!! RAILS!!!

New and Second Hand for Track and Building Purposes, cut to any lengths. Delivered to all parts of the United States.

BLOCK POLLAK IRON COMPANY

Gen'l Offices - First National Bank Bldg., Chicago.

Offices:
Cincinnati, Ohio
St. Louis, Mo.

WE SAVE YOU MONEY.

—STEEL PILING—

NEW and SECOND HAND, Various Lengths

PRICES VERY LOW

WALTER A. ZELNICKER SUPPLY CO. IN ST. LOUIS

Rail, Equipment and Heavy Machinery Bulletin now Ready

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

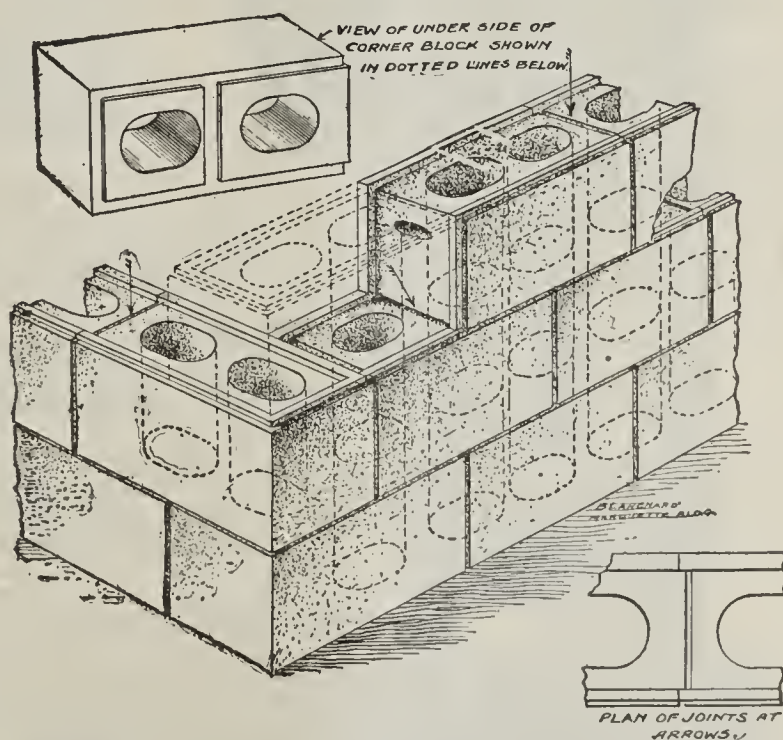
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting Face-Down Machine by the Wet Process

The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

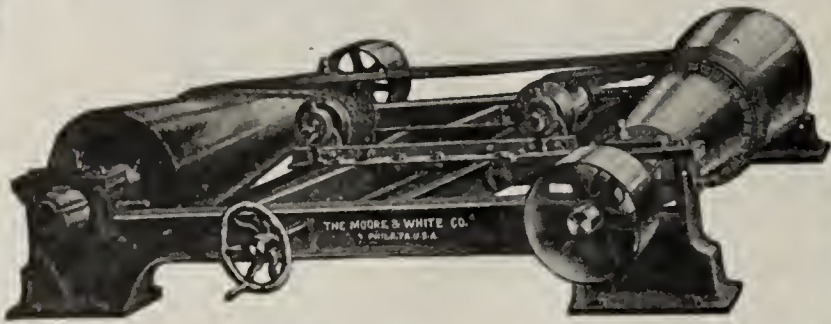
Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and agents wanted in all states and foreign countries.



DIAMOND CONCRETE MACHINERY COMPANY

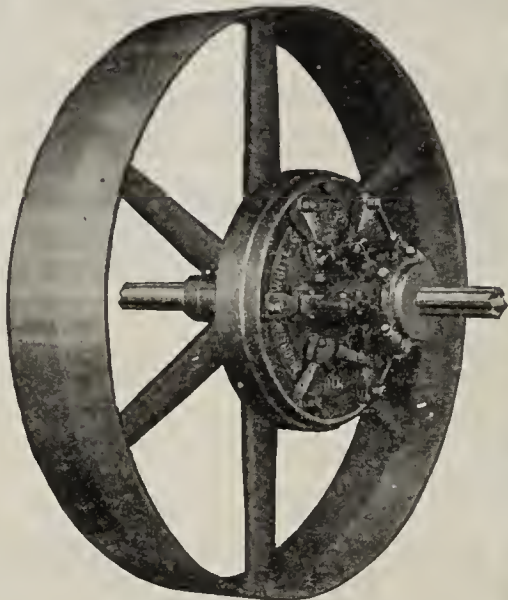
CARDINGTON, OHIO

It will be to any Mill Owner's advantage to investigate these two economical Power devices.



M. & W. Speed Change.

Power
Transmission
Machinery
for
Cement
Mills.



Friction Clutch Pulley.

Write for

Catalogue.

The Moore & White Co.,
Philadelphia, Pa.



Sampling Universal Portland Cement

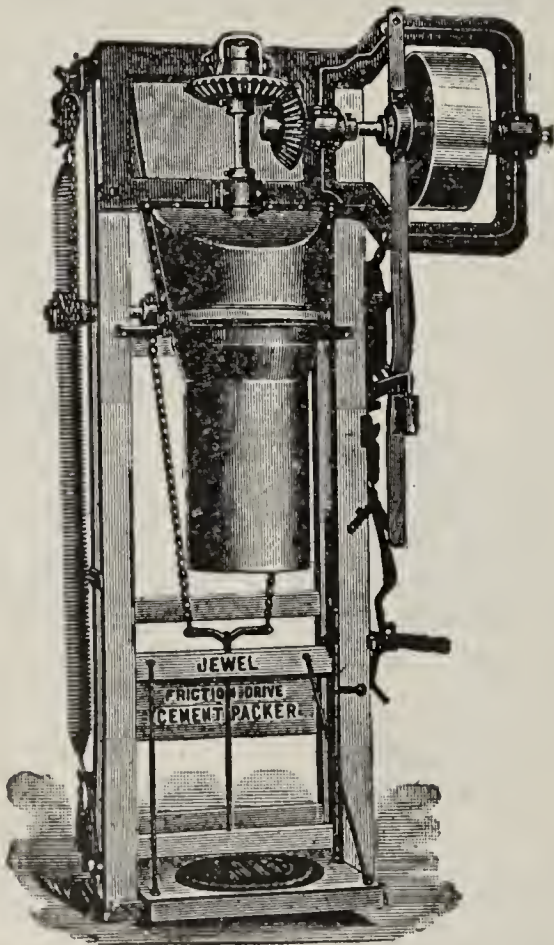
four hundred and fifty times an hour as the finished product leaves the mill is one illustration of the thoroughness and care exercised at every stage in its manufacture. Our method of obtaining fair samples by means of an automatic device which removes from the conveying belt entering the storage bins a certain quantity of cement every eight seconds, was originated and is employed exclusively by this Company.

Universal Portland Cement Co.

Chicago—Pittsburg

Annual Output 8,000,000 Barrels

There is more Cement being packed by the "S. HOWES" Company's Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and sacks.

The "JEWEL" FRICTION driven cement Packer, specially constructed for rapidly packing sacks.

Both machines are equipped with friction pulleys, heavy iron frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company

SILVER CREEK, N. Y.

Apparatus for Chemical and Physical Testing of Cement

EIMER & AMEND

205-211 Third Avenue, New York City

MANUFACTURERS OF & HEADQUARTERS FOR

Chemical Apparatus, C. P. Chemicals and Reagents

Cement Briquette Moulds.

Gilmore Needle.

Standard Sieves of Exact Meshes.

Williams' Sp. Gr. Balance.

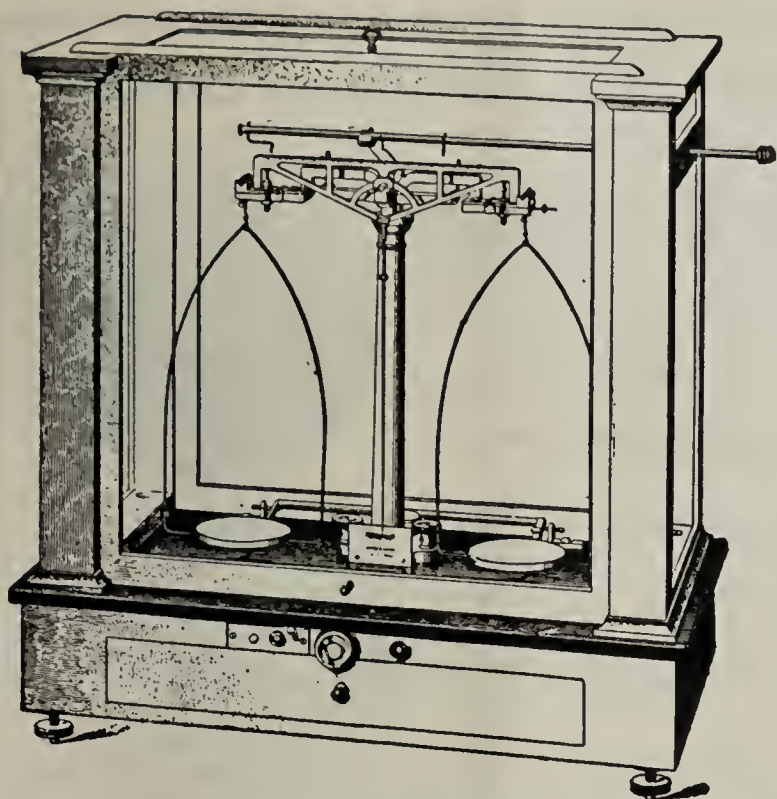
*Specially adapted for determining
Sp. Gr. of Cement.*

(Descriptive Pamphlet sent on request)

*Schumann's, Le Chatelier's,
Jackson's and Candelot's
Apparatus for Sp. Gr. of
Cement.*

Headquarters for **Calorimeters and Pyrometers.**

(Our large illustrated Catalogue gladly sent to Chemists on application.)



F. A. Jones, M. E. Gypsum Specialist

Consulting, Mechanical and Chemical Engineer, in Designing, Construction and Operation of Plaster Mills, (Kettle or Rotary Process), Elevating, Coney-ing and Crushing, Mechanical Drying, (Kiln or Rotary) and Hydrating Plants, Power Houses, Pumping Stations and Water Powers.

Examination, Tests, Analysis and Reports, Plans, Specifications and Superintendence of Construction.

No. 311-C FEDERAL BLD'G.

YOUNGSTOWN, OHIO.

WM. B. SCAIFE & SONS CO.

221 First Ave., Pittsburg, Pa.

WE-FU-GO

and **SCAIFE**

Water Softening, Purifying, and Filtering Systems

— FOR —

BOILER FEED

AND EVERY INDUSTRIAL USE.

Send for Complete Information

DEXTER

Portland Cement
THE NEW STANDARD

Sole Agents **SAMUEL H. FRENCH & CO.** Philadelphia



OWL CEMENT

GERMAN AMERICAN
PORTLAND CEMENT WORKS

E. L. COX,

GENERAL SALES AGENT

1527 Marquette Bldg. CHICAGO, ILL.

E. H. SARGENT & CO.

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN

CHEMISTS SUPPLIES

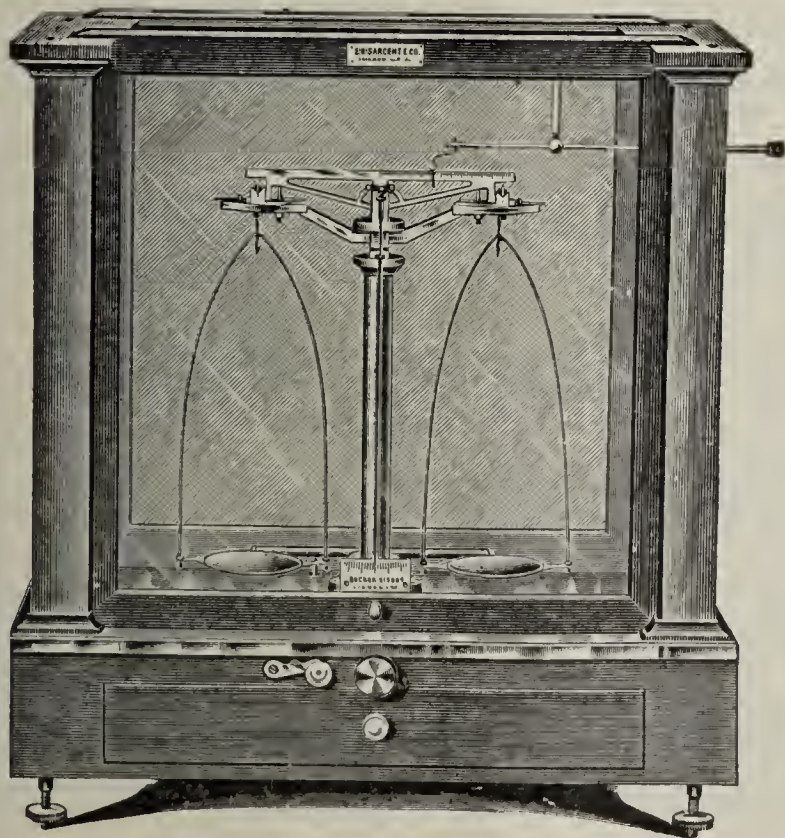
Of high grade only.

We call particular attention to our Cement Mould, Vicat Indenting Apparatus, as improved by us, Gilmore's Needles, Jackson's specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

CHICAGO





Medusa White Portland Cement

Used for entire exterior plaster of
Ritz Hotel, San Francisco,
Cal., here illustrated.

A beautiful product adapted to
ornamental artificial stone work
of the highest grade. Equal or
superior to any other White Port-
land Cement known.

Write for free sample, pamphlet
with instructions for use and price.



MEDUSA WATERPROOFING

(Patented Apr. 23, 1907)

Makes concrete impervious to water and prevents ef-
florescence and discoloration. Gives absolutely perma-
nent results and does not affect strength, setting or
color of Portland Cement.

Used by nearly all the foremost Engineers, Architects,
Railways, Contractors, Block Makers and Cement
Experts.

Obtain our price and circular, also price on Medusa
Gray Portland Cement

SANDUSKY PORTLAND CEMENT Co., Sandusky, O.

"VULCANITE" PORTLAND CEMENT

MAIN OFFICE
Land Title Building
PHILADELPHIA

SALES OFFICE
Flat Iron Building
NEW YORK

PORTLAND CEMENT

WATERPROOFING COMPOUND

Seven Cents per lb. F. O. B. any R. R. Station

We suggest and invite comparison of the unsolicited test reports of cement treated
with our product to those of all others combined.

We Loan Free of Charge a Simple Mixing Machine.

McCORMICK WATERPROOF PORTLAND CEMENT CO.

BANK OF COMMERCE BLDG., ST. LOUIS, MO.

(HIGH CLASS TRAVELING REPRESENTATIVES WANTED.)

The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty.

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa

WANT COLUMNS.

Advertisements in this column are inserted at the rate of two dollars per inch per issue—and no advertisement will be taken for less than two dollars and must be paid strictly in advance.

WANTED.

Cement mill repair men for plant in the East, experienced ones only need apply. Must be sober and will-ing workers. 25 and 30 cents an hour. Address E. O. C., care Cement & Eng. News.

WANTED.

Two cement burners for plant in the East, 25 cents per hour. Address J. N. K., care Cement & Engineering News, Chicago, Ill.

WANTED.

If you are interested in pumps of latest and best styles, send to us for book and catalogue. Pumps of all styles and for all uses. The Columbus Steam Pump Works, West Broad street, Columbus, Ohio.

TELEGRAPHY.

Learn Wireless and R. R. Telegraphy. Shortage of fully 10,000 Operators on account of 8-hour law and extensive "wireless" developments. We operate under direct supervision of Telegraph Officials and positively place all students, when qualified. Write for catalogue. Nat'l Telegraph Inst., Cincinnati, Philadelphia, Memphis, Davenport, Ia., Columbia, S. C., Portland, Ore.

WANTED

the services of a representative to look after our old customers and prospective buyers of our Modern Simple Tax-free Industrial Alcohol Distilling Apparatus, by special successful demonstrative methods for making Aguardiente, Mes-cal, Teguila, Peach Brandy, Solidified Alcohol in Cubes, Denatured Alcohol. Most modern simple 5 Gal. Still and all Sizes to 500 Gal. daily Capacities. Good Commission. Address

The Wood Waste Distilleries Co., Inc.
Wheeling, W. Va., U. S. A.

WANTED.

Chemist with three years experience in Cement Plant as Chemist and Chief Chemist desires position with Cement Company. Graduate of Mass. Inst. of Tech. Address Chief Chemist, care Cement & Engineering News.

Iron-Ore Cement

The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in place of Portland cement for all Marine Construction.

Send for Literature, Etc.

WORM-COX COMPANY

SOLE AGENTS

Marquette Building, Chicago

Denatured Alcohol in Solid Form.

Cleveland Special Dispatch Sept. A well known Wheeling, W. Va., chemist has succeeded in producing chunks of denatured alcohol in crystal form by means of a small infusion of certain acids whereby crystals of an alkaloidal nature very closely resembling physiologically the effects of ethyl alcohol distilled from saw dust. The method employed and the results obtained are somewhat similar to the crystalizing of rock candy or that of Saccharine, containing as it does, 350 times the sweetening strength over that of cane sugar, so this alkaloidal crystalized alcohol contains many times the strength over the ordinary denatured fluid alcohol they will yield 194 proof denatured alcohol with a greater heating and cooking power for stoves than gasoline and it is absolutely non-explosive.

A sample case containing 50 solid cubes, a stove and the secret formula, how simple it can be made at home, will be mailed to you post paid on receipt of \$5.00, or C. O. D. Address:

THE WOOD WASTE

DISTILLERIES Co., Inc.

Dept. C. Wheeling, W. Va., U. S. A.

FOR SALE CHEAP

Two New No. 66 Lindhart Kominuters

Five No. 7 Schmidt Ball Mills

One No. 64 Lindhart Kominuters

The above equipment is in first-class condition

Address: **COPLAY CEMENT MFG. CO., - - Coplay, Pa.**

The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker
1½ inches diameter from the kiln
and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

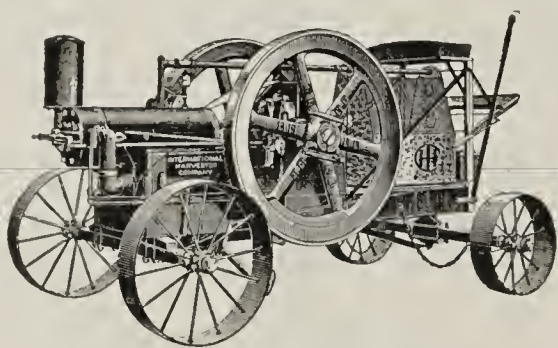
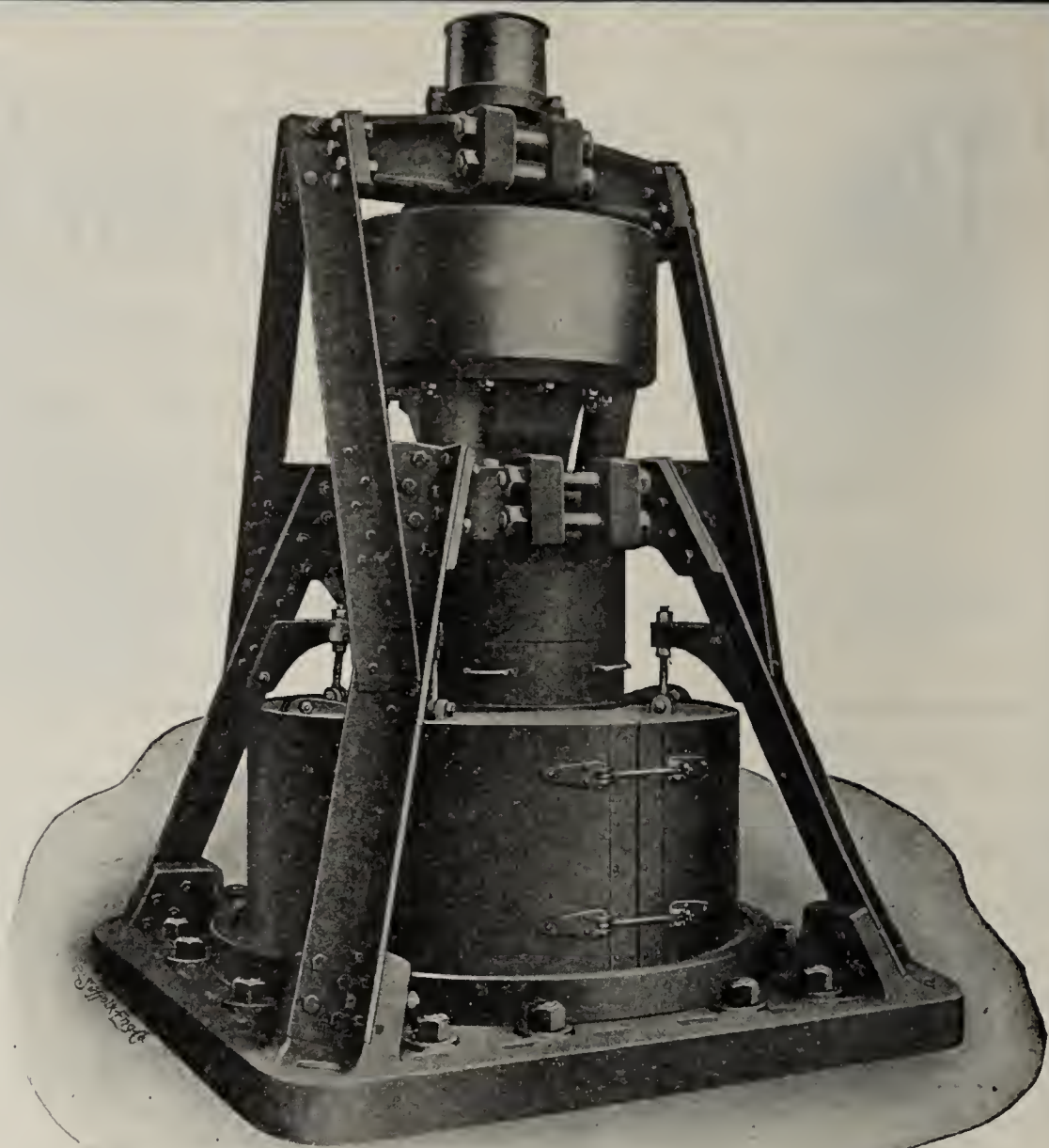
It saves cost in attention.

MANUFACTURED BY

BRADLEY PULVERIZER CO.

37 Walbrook
LONDON, E. C.

92 State Street
BOSTON



I H C GASOLINE ENGINES

Dependable under all Conditions

That is what the concrete worker needs—power he can rely on no matter what the conditions—an engine that will run and run right—winter and summer—in the wet and open as well as housed—that will give good service, anywhere, any time—that will stand up under long hard running or sudden emergency—in short, an I H C.

I H C gasoline engines have proved their reliability through years of hard service in all parts of the world.

Their simplicity and strength make them ideal for concrete mixing and other hard rough work.

And the same high grade construction that makes them most reliable makes them also most economical.

I H C gasoline engines give most power, on least fuel, with least trouble, and for longest service. They may be had in any size or style—vertical or horizontal—air or water cooled—stationary or portable (skids or trucks)—1 to 25 horse power. They offer just the engine you are looking for. Write us for catalogue and full information.

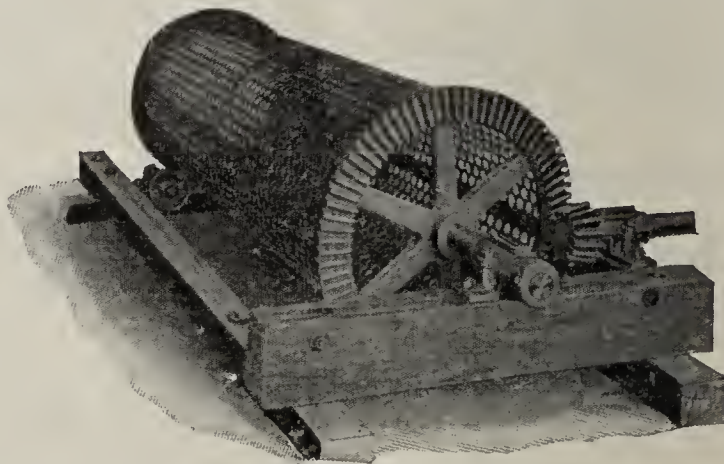
International Harvester Company of America,
(Incorporated)

41 Harvester Bldg

Chicago U S A

WELLER-MADE

Elevating, Conveying and
Power Transmitting Machinery



We furnish a complete line of Screens, Elevators, and Conveyors for Cement Plants, Warehouses, etc.

Efficiency and economy in handling materials is assured by the use of WELLER-MADE Machinery. You are invited to take advantage of our co-operation. Send for 512-page catalog.

WELLER MFG. CO., CHICAGO

THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

Design, Construction, Remodeling and Operation
of Portland Cement Plants

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street New York Canadian Express Bldg., Montreal, Can. 1121 The Rookery Chicago 425 Washington St. San Francisco, Cal. Monongahela Bank Bldg. Pittsburgh Syndicate Trust Bldg., St. Louis, Mo. Norfolk House, Cannon St. E. C., London

The Osborn Engineering Co. Civil, Mechanical and Electrical Engineers

OSBORN BUILDING, CLEVELAND, O.

Experts in the Designing of

CEMENT PLANTS.

Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of **Cement Machinery**

42 NORTH 16TH STREET



PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

Iola, Kansas

Cement Engineers

Just Out!

Architects' and Engineers' Hand Book on
Reinforced Concrete
Construction

ONLY ONE DOLLAR

CEMENT & ENGINEERING NEWS

22 Fifth Avenue, - - Chicago

COLONIAL TRUST AND SAVINGS BANK

205 La Salle Street, CHICAGO

Capital and Surplus \$1,100,000.00

We are offering High Grade Seasoned 5 to 6% Bonds at attractive prices.

Particulars upon Application



THE IMPROVED DIETRICH'S CLAMP

and Form System for Hollow Walls

By the use of the Improved Dietrichs Clamp and Form System for Hollow Walls the

COST OF CONCRETE CONSTRUCTION IS REDUCED 50%

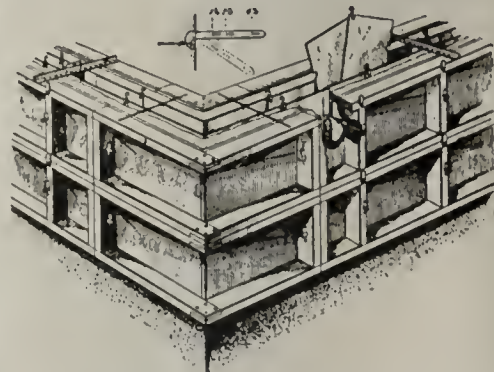
and the builder also secures a

PERFECT DAMP-PROOF WALL

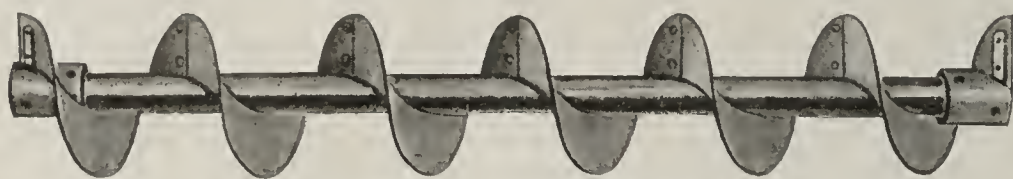
This system is based on the panel principle and employs removable sheet iron inner forms with sheet iron spacer. Corners, doors and window openings are provided for.

Write for pamphlet giving full information

DIETRICH'S CLAMP CO.
LITTLE FERRY, N. J.



ELEVATING—CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys, Shafting, Shaft Bearings, Link Belting, Special Chains



HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES.
Catalog for the asking.

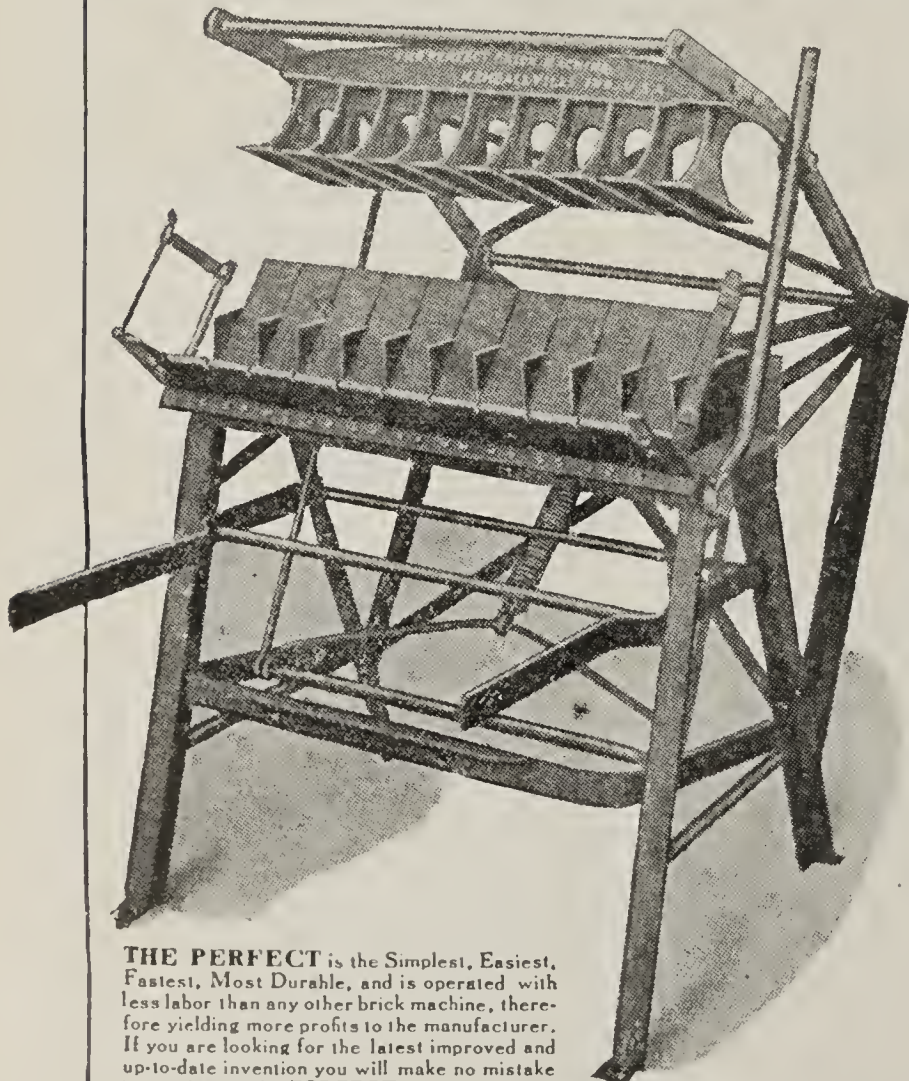
SKILLIN & RICHARDS MFG. CO., CHICAGO

THE PERFECT BRICK MACHINE

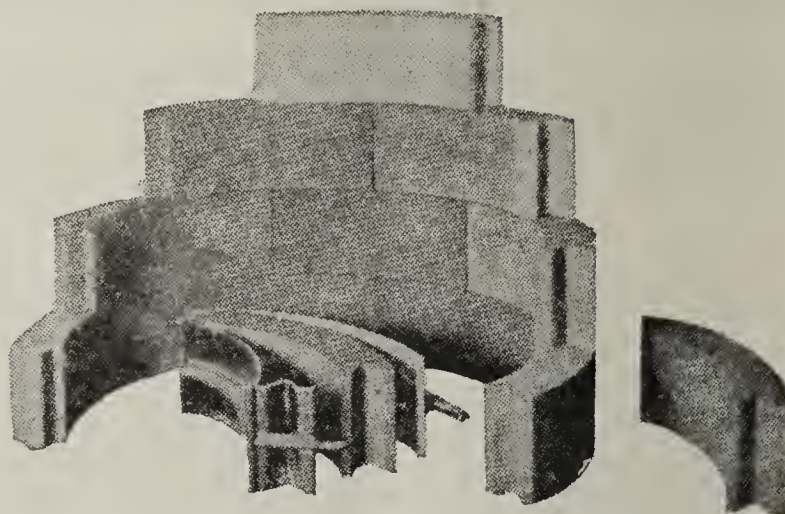
THE PERFECT CISTERN AND SILO MOLDS

ARE USED IN ALL PARTS OF THE WORLD

OUR MOLDS are the BEST and CHEAPEST ever offered to the public



THE PERFECT is the Simplest, Easiest, Fastest, Most Durable, and is operated with less labor than any other brick machine, therefore yielding more profits to the manufacturer. If you are looking for the latest improved and up-to-date invention you will make no mistake in purchasing the PERFECT.



The Perfect Well, Cistern and Silo Mold.

HERE IS OUR PRICE LIST

No. 3 Circle Mold is 3 ft. diam.	No. 10 Circle Mold is 10 ft. diam.
" 5 " " 5 ft. "	" 12 " " 12 ft. "
" 7 " " 7 ft. "	" 14 " " 14 ft. "
	" 16 " " 16 ft. "

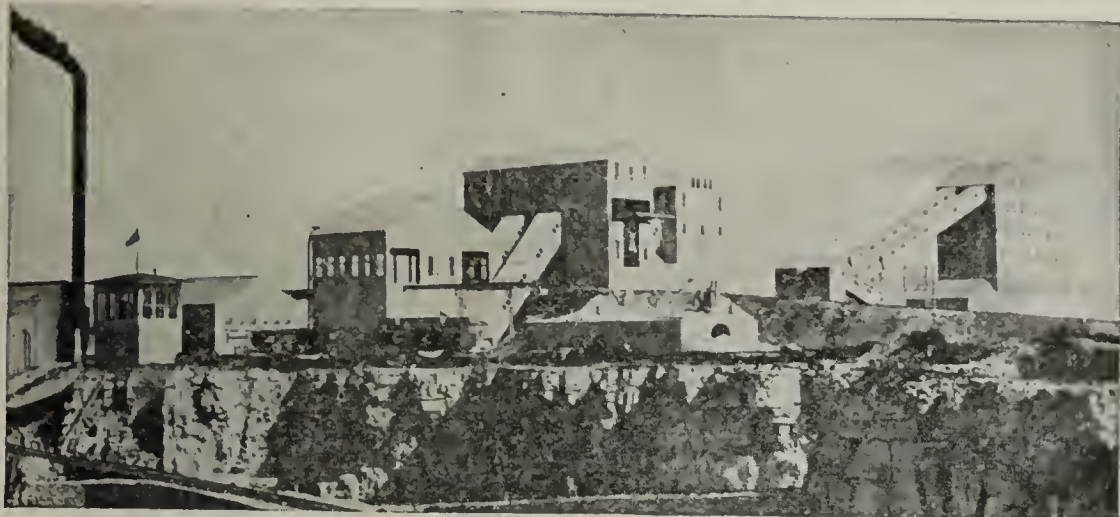
All sizes up to 7 foot retail at \$12.00 each.

All other sizes retail at \$15.00 each.

The Circle Molds vary in length from 22 to 28 inches, depending upon the diameter of its circumference.

In ordering Circle Molds always give the diameter of what you are going to build and I will then understand the kind of a circle mold you desire.

C. S. WERT, 602 North Main Street, Kendallville, Indiana, U.S.A.



Dolese & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world. Machinery throughout installed by us.

OLSON BROS. & CO.

Engineers and Contractors

Cement Mill Machinery Erected, Stone Crushing
Plants Equipped and Erected. :: :: ::

ALSO COMPLETE PLANTS FOR HANDLING
COAL, SAND, GRAVEL, ORES, ASHES, ETC.

MODERN POWER TRANSMISSION
Elevating and Conveying Machinery.

Tanks and Vats, Especially in Connection with Machinery

2418-22 Bloomingdale Ave., Chicago

THE PERFECTION CONCRETE MIXER

A Perfect Feed === A Thorough Mix

"We have three Perfection Concrete Mixers and they do the work in fine shape. I do not know of a mixer on the market that will do the work for the same money."

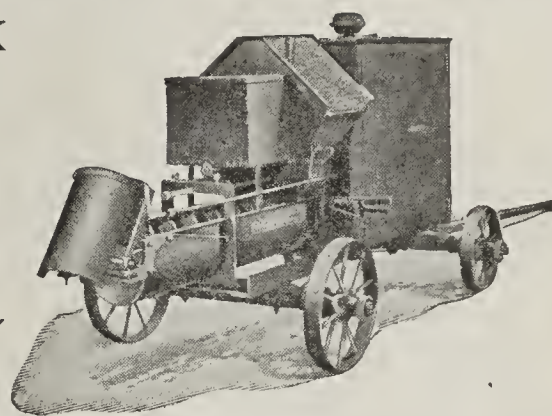
NEWELL CEMENT TILE CO.
Newell, Iowa

We have a 32-page catalog awaiting your request. It is absolutely free, shall we send it?

THE CEMENT TILE MACHINERY COMPANY

RATH STREET

WATERLOO, IOWA



JUST A REMINDER

ATLAS DRYERS—DRY NEARLY EVERYTHING

THE ATLAS DRYER CO., CLEVELAND, OHIO

"COMPETITION"

demand the exercise of the strictest economy in all lines of business. Our ability to take advantage of "Sheriffs," "Receivers" and "Bankrupt" Stocks makes it possible to quote you prices that mean a positive saving of from 30 to 75%. An inquiry will give us a chance to prove our assertions. Write today.

ROCK CRUSHERS.

1—9 x 15 Allis Chalmers Jaw Crusher.

ROCK DRILLS.

6—Ingersoll-Sargeant Rock Drills, size 3 3/4 inches.

6—Ingersoll-Sargeant Rock Drills, size 3 1/2 inches.

Fitted for steam or air.

HOISTING ENGINES.

1—12x16 double cylinder, heavy duty LIDGERWOOD hoisting engine.

1—6x8 Marine Iron Works double cylinder, single drums, reversible in steam chest.

PUMPS.

1—20x13x12 Wheeler & Tappen Duplex Pump.

1—14x8 1/2 x 10 Duplex Laidlaw-Dunn.

1—12x7x12 Duplex Smith Vall.

1—10x6x10 Duplex Dean.

5,000 rolls rubber, leather and canvas belting, structural iron, shafting, pulleys, couplings, steel wire and manilla rope. Smoke stacks, corrugated roofing and siding, hose hydrants, tanks. We can save you money on anything you require.

STANDARD IRON PIPE.

300,000 ft. 1 1/4 inch

150,000 ft. 1 1/2 inch

250,000 ft. 2 inches

12,000 ft. 10 inches

4,000 ft. 12 inches

30,000 ft. 8 in. Cast

Iron

300 ft. 24 in. Cast

Iron

IRON CASING.

35,000 ft. 1 3/4 inch

40,000 ft. 3 1/4 inches

60,000 ft. 3 3/4 inches

8,000 ft. 5 5/8 inches

9,000 ft. 6 1/4 inches

1,000 ft. 6 5/8 inches

1,250 ft. 8 1/4 inches

STRUCTURAL STEEL AND IRON.

The most complete line of Structural Steel and Iron in the city, consisting of I-beams, channels, angles, T's, columns, truss rods, joint anchors, girders, sill plates, sidewalk lights, coal-hole covers, new and relaying rails, bridge work, etc. We cut to any size, punch, rivet and fabricate as far as practical, and deliver all

ready to assemble, at a saving to you of 30 to 60 per cent. Send plan of the work you have in view and let us make you an estimate.

TANKS.

12—1,000 gallon capacity tanks.

42—1,500 gallon capacity tanks.

6—3,000 gallon capacity tanks.

15—3,600 gallon capacity tanks.

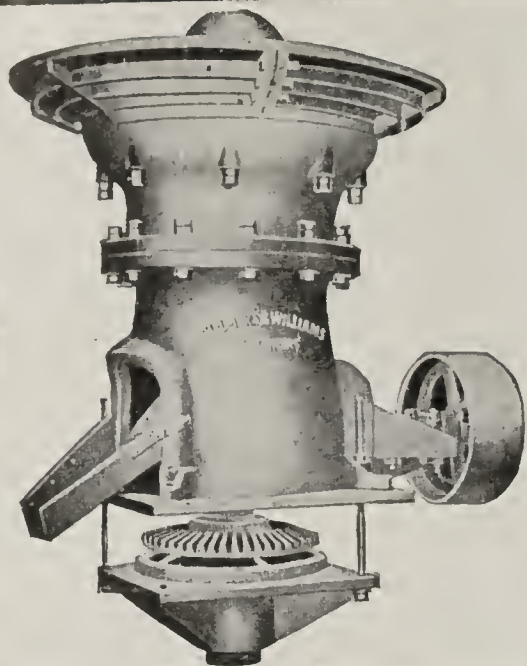
STEEL STORAGE TANKS.

Capacity, 4,500 to 6,500 gallons. These tanks were used only a short time in railroad service. Very heavy construction—1/4" steel with 5-16" heads; domes in proportion to size of tank, and fitted with 15" screwed manhole. We will give them rigid inspection and paint before shipment. Prompt shipment can be made from points South, East and West.

SEND FOR OUR NEW 500-PAGE CATALOG NO. 962.

A wonderful book of facts and information of the utmost value to everyone. Send to-day. It will cost you nothing.

CHICAGO HOUSE WRECKING CO. 35th, and Iron Sts., CHICAGO, ILL.



Kennedy Gyratory Crusher

The only Crusher built with a ball and socket eccentric which will lend itself to any change in the inclination of the main shaft. Improved hopper, more efficient dust collars.

— ALSO —

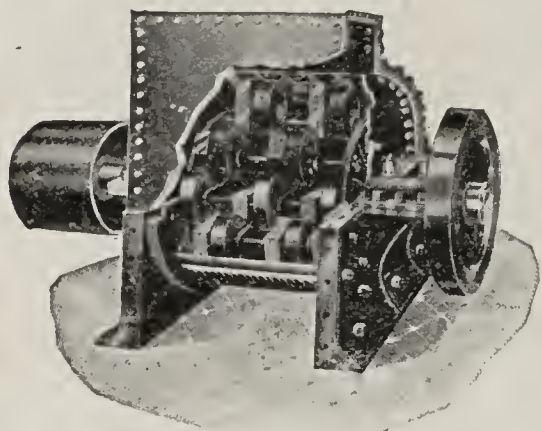
Cement Making Machinery

Kilns, Dryers, Tube Mills, Ball Mills, Elevators, Conveyors, Feeders, Revolving Screens and Crushing Rolls.

Chalmers & Williams Inc.

1927 Commercial National Bank Building, - - - Chicago
120 Liberty Street, New York

American Ring-Hammer Pulverizer



Six Sizes.

will pulverize

Cement, Clinker, Shale, Limestone, Coal, Etc.

30 days' working test at your works allowed. Machines guaranteed
All Grinding Parts Made of MANGANESE STEEL.

Write for particulars and circulars.

AMERICAN PULVERIZER CO.

410 JACCARD BUILDING

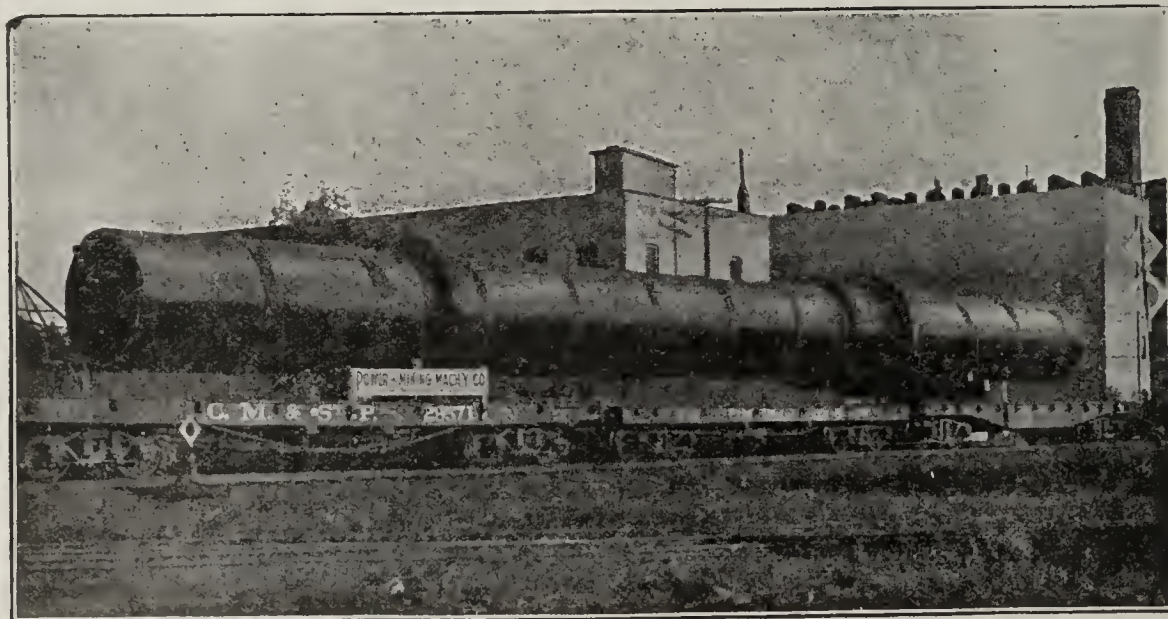


ST. LOUIS, MO.

Cement Mill Machinery

A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process.

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



Write for Catalogue No. 17.

Power & Mining Machinery Company

MILWAUKEE, WIS., U. S. A.

CHICAGO.

NEW YORK.

ATLANTA.

EL PASO.

SAN FRANCISCO.



World's Largest All-Reinforced-Concrete Office Building!

¶ The new **Plymouth Building**, at Minneapolis, sets a new record for reinforced concrete construction—

¶ A **fifteen-story** office building built of **concrete** and reinforced throughout with **M-B Bars**—not **part** concrete, but **all** concrete—**columns, beams, slabs, and wall spandrels all reinforced concrete!**

¶ The **Plymouth** consists of two basements, twelve upper stories and one attic. In **height**, and in **floor** area, it is the largest **office** building ever erected of **all-reinforced-concrete** construction. It is 202 feet 6 inches high and has

480,000 square feet of floor area.

¶ The largest all-reinforced-concrete building of any kind is the Montgomery Ward Building, Chicago, and this, too, is reinforced exclusively with **M-B Bars**.

¶ Thus, **two world's** records in reinforced concrete construction have been accomplished with **M-B Bars**

¶ The owners of the **Plymouth** found that, as compared with **structural-steel-hollow-tile** construction, they **saved one hundred thousand dollars** by using **all-concrete** construction and reinforcing throughout with the

M/B *Special* Open Hearth Bar (Cold Twisted) FOR REINFORCING CONCRETE

¶ The **M-B Bar** was used exclusively in the **Plymouth**, The Montgomery Ward, and hundreds of noted buildings, because it is a superior steel, rolled from **new billet** stock and **twisted cold**, and is the only bar which combines both **high elastic limit and great ductility**.

¶ With an elastic Limit of 60,000 lbs. per square inch, the **M-B Bar** can be **bent double while cold** without fracture.

¶ It possesses the **great strength** of high-carbon steel

without its brittleness, and the **great ductility** of low-carbon steel without its excess weight and cost. It is the only **steel** which makes it possible to secure economy of design **consistent with absolute safety**.

¶ **M-B Bars** are the **safest** and the **cheapest** known reinforcement for concrete.

¶ Satisfy yourself on this score by sending for our book of **facts** and formulae—"The Bar That Never Failed."

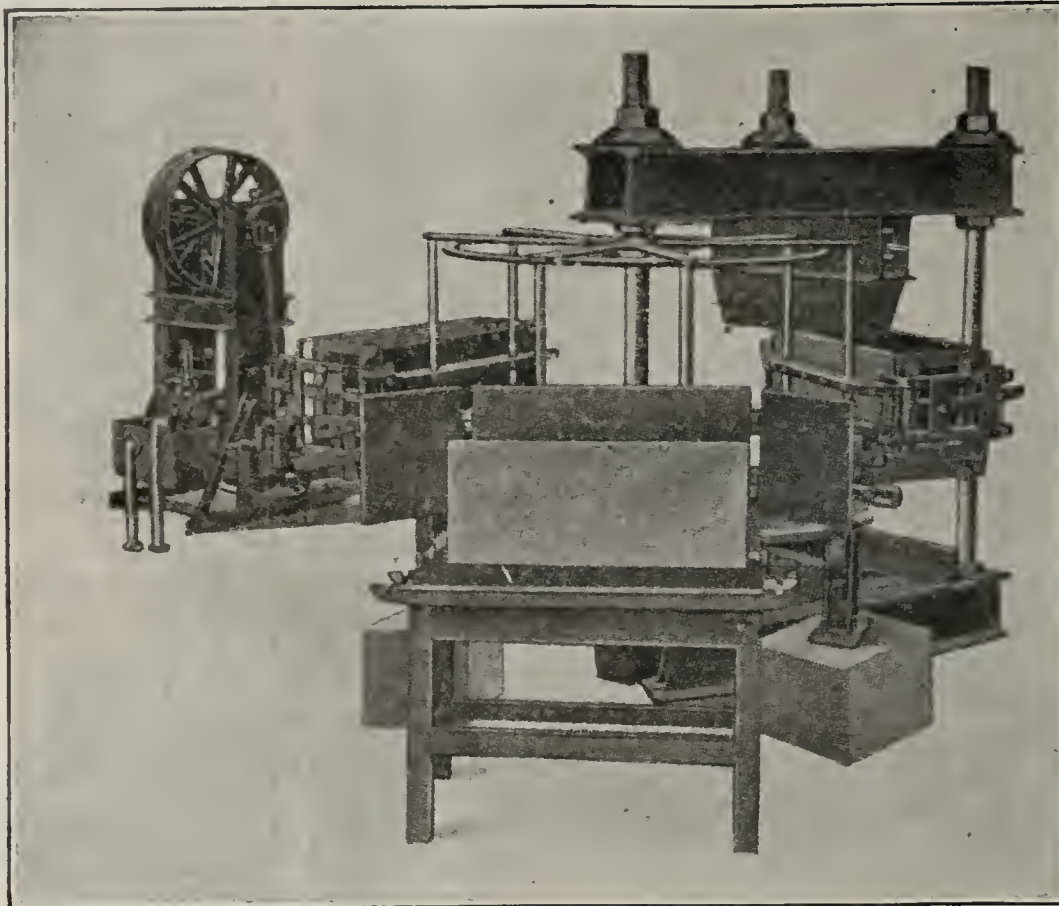
WILLIAM B. HOUGH COMPANY

"Where the Reliable Reinforcing Steel Comes From"

Home Office: Chicago, U. S. A.

Detroit :: Minneapolis :: Indianapolis :: Des Moines

A DENSE CONCRETE



A Hydraulic Ram Pounding Concrete Into Blocks

TWO MEN do the work. From 1000 to 2000 blocks per day. Three quick-acting mold boxes rotating over the Ram on a Revolving Table, one being filled, one receiving the pounding, one delivering the finished block.

The Fisher Hydraulic Machine pounds a wet mixed mortar together with a Hydraulic Ram and produces a dense concrete with less than 5% absorption, with a high crushing strength, in any style to suit the demand.

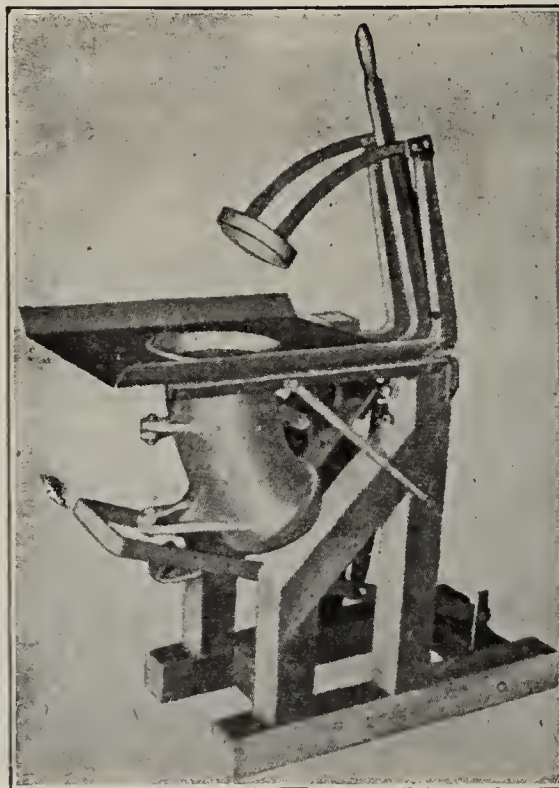
Ask for Catalogue or any information regarding our system.

Fisher Hydraulic Stone & Machinery Co.
MOUNT GILEAD, OHIO.

Concrete Sewer Pipe Bends

**The Only Machine
of Its Kind
on the Market.**

Concrete Sewer Pipe
Bends Made on the
**RICKMAN SEWER PIPE
BEND MACHINE** Make
Money for the Manu-
facturer.



**The Latest Thing
Added to the Concrete
Machinery Line.**

ONE MAN can make from 15 to 20 curved sections of pipe per hour. Shovel in the material, tamp it with the tamping ring, operated by foot lever, attach the bell-end form, complete the section, withdraw core from below, by lever, carry the pipe away to a pallet and bring the outer mold back to the machine.

You Need This Machine to Complete the Equipment of Your Tile Factory

Write for Circulars and Prices

R. L. RICKMAN CO., 987 Westminster Avenue,
VANCOUVER, B. C.

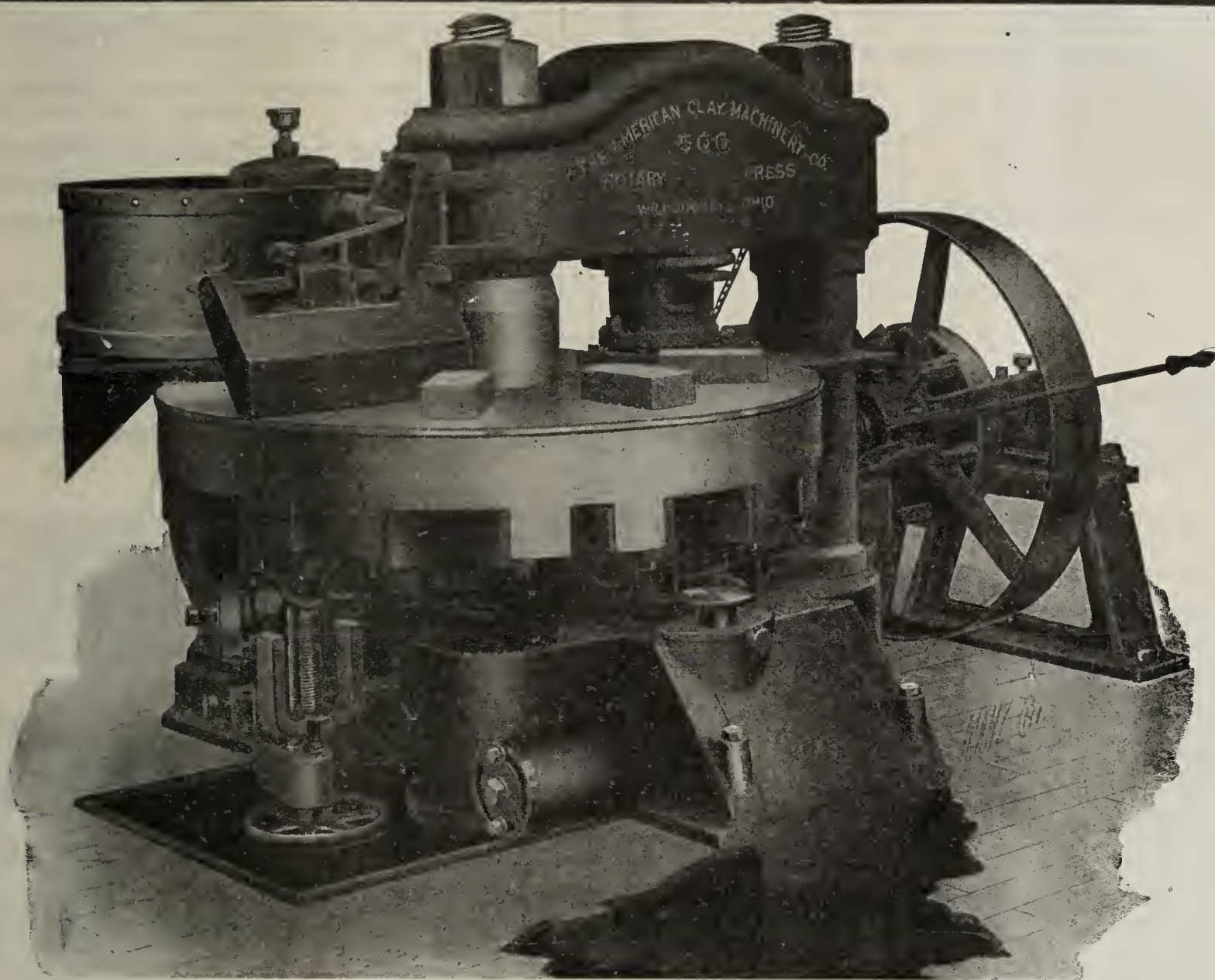
Many years' experience proves the **DIVISION METHOD** (patented) the only Economical, Efficient and Reliable, as well as the most Scientifically and Mechanically Perfect Process for the manufacture of high-grade **SILICA BRICK AND STONE**—the **Twentieth Century Building Material**.

—Let Us Give You Full Information—

International Sand-Lime Brick & Machinery Co.

ENGINEERS AND CONTRACTORS
FOR SILICA BRICK AND STONE FACTORIES

90 WEST STREET, NEW YORK CITY



SAND-LIME BRICK

NO better or more satisfactory line of Sand-Lime Brick machinery will be found on the market than the "Built Right, Run Right" line. In addition to other machinery we build four types of presses to meet the varying needs of the trade. Our No. 500 Eight Mold Rotary Brick Press here shown is excellently adapted for modern plants. It has ample proportions. The molds have interlocking HARD steel liners quickly removable. The pressure is double with relief device attachment and ejecting device. One brick is pressed at a time, the table being locked while brick is under pressure. The mold charge is simple and effective insuring a uniform charge. This press has forged steel shafting and bronze bushings. It is an excellent machine throughout with many features of merit. Complete description for the asking. In addition to Sand-Lime Brick Machinery we also build every machine and appliance required for the manufacture of Clay products by all processes. Complete Catalogue for the asking.

The American Clay Machinery Co.

WILLOUGHBY, O., U. S. A.

SELECTED WHITE SAND

For.

Ornamental
Concrete
Stone



For.

Hard
Plaster
Finishing

Cement
Block
Facing

Exterior
Plastering

Stone & Marble Sawing

Shipped in paper lined box cars or 150 lb. bags

UNITED STATES SILICA CO.

1041 AMERICAN TRUST BLDG.

CHICAGO

Hotel Cumberland NEW YORK

S.W. Cor. Broadway and 54th St.
Near 50th Street Subway Station and 53d Street Elevated

HEADQUARTERS FOR THE CEMENT
AND MACHINERY MEN.

New Modern Fire Proof

All Outside Rooms. No Carpets. All Oriental Rugs.
Transient Rates \$2.50 with Bath and up.
10 minutes walk to 20 theatres. Send for Booklet.
HARRY P. SIMPSON, Formerly with Hotel Imperial.
R. J. BINGHAM, Formerly with Hotel Woodward

CHARLES F. McKENNA, Ph. D. Inspection of Cement

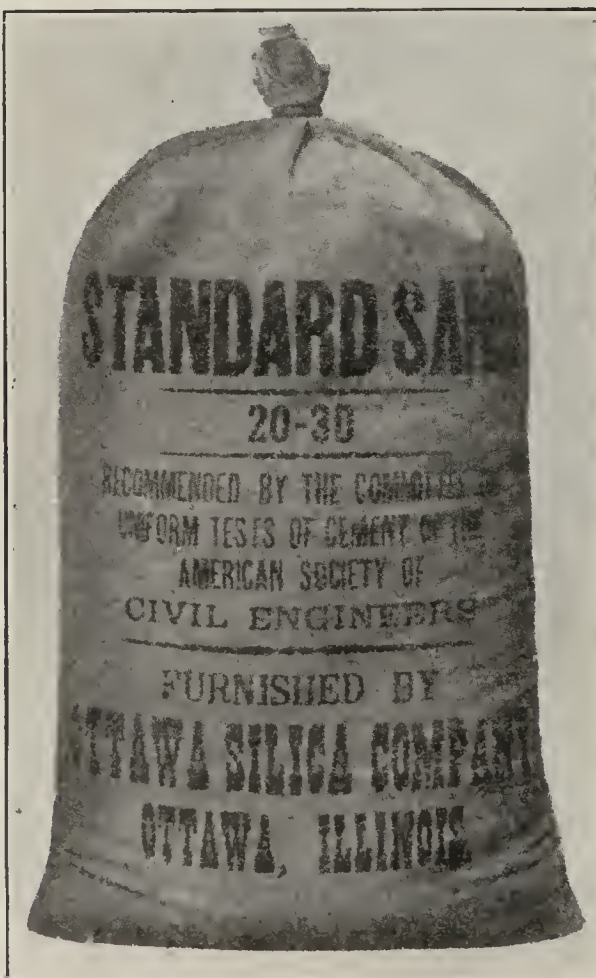
and all other Engineering Materials. Examination of
Properties and of Economical Operation of Works.

Consulting and General Practice in
Chemistry, Technology, Chemical
Engineering and Chemico-
Legal Cases.

Long Distance Telephone. Cable Address: PLAT PEARL
Laboratories: 221 Pearl St., New York City
Offices: 50 Church Street

WASHED-STEAM DRIED and SCREENED

Ottawa White Sand



Unexcelled for
facing concrete
blocks, orna-
mental concrete
stone, etc.

Analysis 99.88

Prices, Freight
Rates and
Samples on
Application.

You can or-
der less than a
carload, in
fact shipments
as small as
five 175 lb.
bags can be
delivered eco-
nomically.

SEE OUR EXHIBITS

New York Cement Show, Space No. 132. December 14-20, 1910
Chicago Cement Show, Space No. 11. February 17-23, 1911

DU PONT

OFFICES

BIRMINGHAM
BOSTON
BUFFALO
CHICAGO
CINCINNATI
DENVER
DULUTH
HAZLETON
HOUGHTON
HUNTINGTON
JOPLIN
KANSAS CITY
MEMPHIS
MEXICO CITY
NASHVILLE
NEW ORLEANS
NEW YORK
PHILADELPHIA
PITTSBURGH, PA.
PITTSBURGH, N.Y.
PORTLAND
SALT LAKE CITY
SAN FRANCISCO
SCRANTON
SEATTLE
SHREVEPORT
SPOKANE
SPRINGFIELD
ST. LOUIS
TERRE HAUTE

RED CROSS SEMI- GELATIN

when used
in cold water, will
not become chilled
and insensitive as
quickly as other
standard dynamites.

1802
1910

EXPLOSIVES

E. I. DU PONT DE NEMOURS POWDER CO., Wilmington, Del., U.S.A.

COPYRIGHTED BY E. I. DU PONT DE NEMOURS POWDER COMPANY, 1910

WAINWRIGHT GALVANIZED STEEL CORNER BAR

For Protecting Edges of Concrete Curbs, Steps, Columns, etc.



THE ONLY EFFECTIVE
Concrete Edge Protector

OFFERED TO THE CON-
TRACTING PUBLIC.

"WAINWRIGHT PATENTS"

March 9, 1897; November 22, 1898; May
5, 1903; March 26, 1907; August 29,
1907; August 2, 1910.



This bar has been in public use for more than ten years as the
main feature of the

WAINWRIGHT STEEL-BOUND CONCRETE CURB

Absolutely Non-breakable. Cheaper than Granite

Handsome than Granite and Much Stronger.
Continuous in Construction, hence Never Out
of Line.

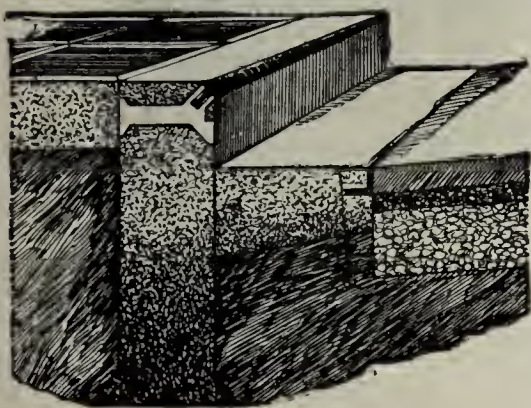
GALVANIZED STEEL CORNER BAR pre-
vents Chipping or Breaking on Edges.

Cannot be Displaced by Frost.

Never Requires Re-setting or Repairs.

MECHANICALLY PERFECT AND UN-
EQUALLED FOR CURVED CORNERS.

THE BEST IN THE WORLD



Over Three Million Feet in Use in More Than
Three Hundred Cities in the United States and
Foreign Countries.

**THIS CURB WILL STAND HARDER USE AND LAST TEN TIMES
AS LONG AS PLAIN CONCRETE CURBING**

CONTRACTORS can make money by laying this curb.

CITY ENGINEERS can save money by specifying it.

ARCHITECTS are invited to read pages 1278 and 1279 "Sweet's index"

METAL PARTS FOR SALE

Send for Copyrighted Booklet No. 18.

STEEL PROTECTED CONCRETE CO., Real Estate Trust Building., Philadelphia, Pa.

When You Sit Down To Figure The Dollars Saved In A Concrete Mixer

IT'S not the first cost that's important but how soon the investment has been returned.

—There's the up-keep, the quantity produced, the quality of mixing and the saving in the pay roll when pay day comes.

—Quality in a mixer pays dividends when initial cost is forgotten.

But it costs just as much to build a mixer embodying the ideas in mixing of 5 or 10 years ago as it does the best mixing practice now.

Its not what you pay but what you buy that counts.

Here's an epitome of the fulfillment of present day mixing you buy in the

Koehring Concrete Mixer

The heaviest drum on any mixer—greatest strength in the most important wearing part.

Three independent, positive mixings in the one drum—most rapid mixer made.

Trunnion rollers placed close to ends to give drum great stability.

Rollers cast with broad faces and chilled as hard as tempered steel.

Double-gear drive close to ends equalizing uneven strains.

Charged direct from barrows on a level with the ground.

No elevated runways of any kind required.

Simplest charging elevator on any mixer.

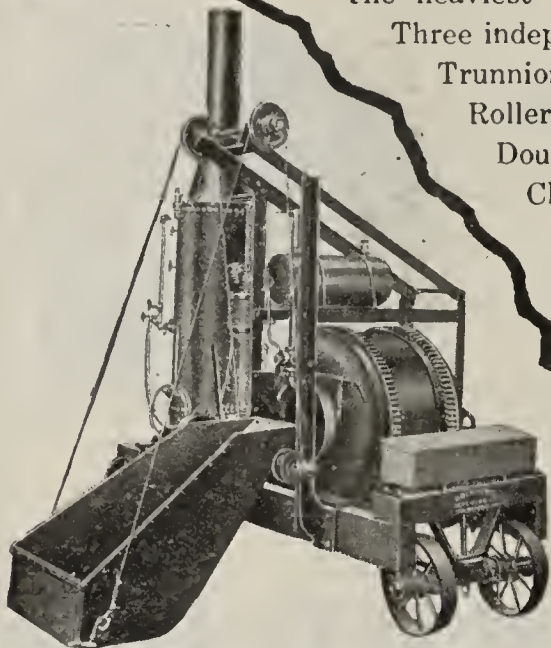
Discharge chute does not interfere with barrows.

Discharge always under perfect control.

Discharges by simply raising inner end of chute.

Equipped with steam, gasoline or electric power.

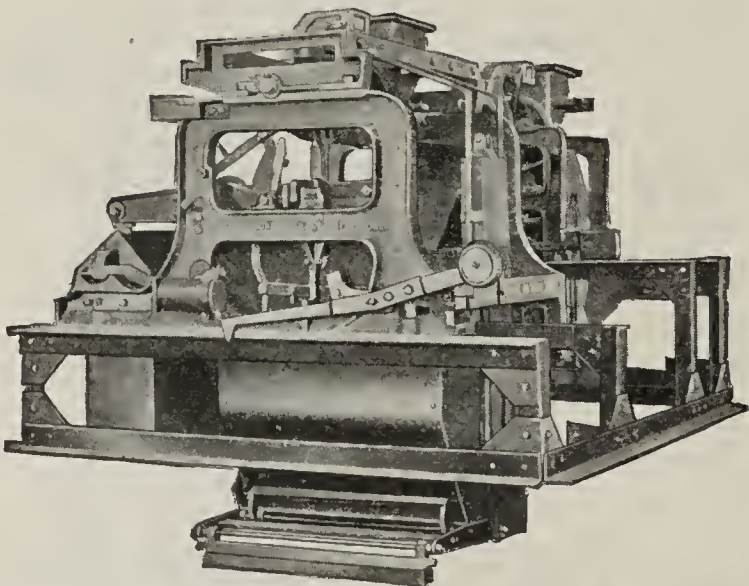
A card will fetch the catalog: mention "Catalog B."



Koehring Machine Co.

614-616 Germania Bldg., Milwaukee, Wis., U. S. A.

TO MAKE THE BEST CEMENT, USE Richardson's Automatic Proportioning Scales



Two or more scales yoked together with our Electric Discharge Mechanism will weigh Crushed Raw Materials direct from bins with perfect accuracy and discharge simultaneously.

These machines fitted with our Conveyor Feed will also weigh Pulverized Materials direct from bins.

Greatest Possible Range of Weights. Exact Proportions Absolutely Guaranteed. Continuous Uninterrupted Operation.

Similar Machines for Clinker and Gypsum. Automatic Hopper Scales for weighing Cement to Stock Bins. Automatic Bagging Scales for Finished Cement. Speedy and most accurate yet devised.

Write for particulars to

RICHARDSON SCALE COMPANY

16 Park Row, NEW YORK

122 Monroe St., CHICAGO



None Just As Good

The book, "REINFORCED CONCRETE IN FACTORY CONSTRUCTION," will be sent for 10c. It illustrates and describes many different types of factories built of concrete. It demonstrates the economy, safety, convenience and adaptability of concrete for all factory purposes.

Other books in the Atlas Cement Library:

Concrete Houses and Cottages Vol. I. Large Houses \$1.00
Vol. II. Small Houses 1.00

Concrete Construction about the Home and on the Farm, Free

Concrete in Highway Construction 1.00

Concrete in Railroad Construction 1.00

Concrete Cottages, Free Concrete Garages, Free

If your dealer cannot supply you with Atlas, write to

THE ATLAS PORTLAND CEMENT COMPANY
DEPT. D. 30 BROAD STREET, N. Y.

Largest productive capacity of any cement company in the world. Over 50,000 barrels per day.

INDEX

TO THE

Cement and Engineering News

Vol. 22. January—December, 1910.

MISCELLANEOUS.

Asso. of American Cement Mfrs.....	6
Canadian Cement Show.....	119
Cement Exposition—Mid-West.....	524
Cement Deposits in Wisconsin.....	103
Chicago Building Code.....	515
Cement Property in W. Va.....	66
Danger in Drying Coal.....	476
Improved Circuit Tester.....	440
Iowa Convention.....	205
Jeffrey Exhibit at New York Cement Show.....	475
Meeting of Peninsula Cement Co.....	163
Mechanical Cement Unloader at Panama.....	439
National Asso. of Cement Users.....	100
Northwestern Office, Wm. B. Hough Co.....	211
Northwestern Cement Products Asso.....	25
W. D. Phillips Resigns.....	211
Mr. Reiche Abroad.....	440
Sand Lime Brick News.....	159
Sails for Phillipines.....	208
Washington Cement Survey.....	23
Workmen Protected in European Cem. Plants.....	524

ILLUSTRATIONS.

Adjustable Steel Centers.....	60
Air Separators.....	199
Anaheim Water Tower.....	369
Country Residence in Calif.....	19
Concrete Silo.....	21
Concrete Culvert.....	237
Concrete Bungalow.....	294-295
Concrete Garages.....	324-336-337
Concrete Elevators.....	341
Concrete Water Tower.....	412
Concrete Filtration Tank.....	461
Concrete Ry. Station.....	479
Dump Cars—A. Koppel Co.....	252
Girderless Floor.....	477
Helm Block Machine.....	254
Lincoln Pk. Electr. Light Poles.....	141
Koehring Mixer.....	153
Poured Concrete House.....	5
Plant of the Northwestern Steel & I. Works.....	114
Plant of Tosa Cement Co.—Japan.....	166
Photo of Visitors, Universal Plant.....	214
Residence of Medusa White Cement.....	45
Reinf. Concr. Caissons.....	93-107-109
Rainbow Falls Dam.....	151
Robins Conveyor.....	159
Riverside Cement Plant.....	196-197
Rapidly Constr. Concrete Bldg.....	200-201
Reinf. Concr. Stadium, Tacoma.....	436
Sewer Pipes of Cement.....	188
Stucco Residence.....	281

Stucco on Frame Houses.....	291
San Jose School.....	480
Warehouse Illinois Glass Co.....	478
Water Softener, Wm. B. Scaife.....	116-117

EDITORIALS.

Building Regulations for Concrete Construction.....	142
Cement Plants Operated by Blast Furnace Gas.....	238
Chicago Cement Show.....	94
Disputable Patents.....	414
Fine Grinding of Cement.....	462
Lesson Taught by Last International Congress.....	46
Puzziolanas.....	371
Reasons for Developing our Natural Resources of Natural Puzziolanas.....	190
Truth about Concrete.....	282
Testing of Cement and Concrete.....	6
Uriah Cummings.....	508
Waterproofing Properties of Colloids.....	326

BOOK NOTICES.

Building Estimator.—By Wm. Arthur.....	296
Channons Catalog.....	211
Chicago Belting Co.'s Catalog.....	59
Concrete Pottery and Garden Furniture.....	22
Concrete Estimator.—By F. Rings.....	348
Hand-book for Inspectors.....	254
How to Use Concrete.—By W. Boynton.....	251
Hendricks Comm. Register.....	483
Jeffrey Booklet.....	476
Miracle Booklet.....	213
Modern Manufacturing of Portland Cement.—By Percy West.....	483
Proceedings of National Asso. of Cement Users.....	67
Producer Gas Fired Furnaces.—By O. Nagle.....	199
Tile Talks.....	291
Weber Chimney Pamphlet.....	67
Zelnicker Bulletin.....	430

REINFORCED CONCRETE CONSTRUCTION.

Bamboo Reinforcement.....	26
Cement Brick.....	25
Concrete Surface Finish.....	18-19
Cement Blocks of Grand Rapids.....	55
Concrete Products.....	68
Concrete Steel Caissons.....	106-113
Concrete Barges at Panama.....	159
Concrete Vs. Terra Cotta Tile.....	164
Concrete Blocks in Scotland.....	217
Concrete Street Pavement.....	208
Concrete Building in Three Months.....	200
Concrete Bungalows.....	294

Concrete Mills.....	295
Concrete Construction and Fire Loss.....	299
Concrete Garages.....	336-338
Concrete Elevator.....	341
Concrete Water Tank.....	344
Concrete Scows.....	345
Concrete Snow Sheds.....	349
Concrete Storage Tanks.....	384
Concrete House in Tropics.....	384
Concrete Railway Tie.....	387
Concrete Circular Bins.....	388
Concrete's Conquest.....	391
Concrete Telegraph Poles.....	392
Concrete Patterns.....	393
Columns Head for Girderless Floor.....	477
Concrete through Metal Pipes.....	474
Disintegration of Cement Floors and Sidewalks.....	525
Experiments on Cement Tile.....	342
Failure in Stucco Work.....	424
Irrigation Project, Colo.....	202
Inexpensive Homes of Concrete.....	292
Improvements in Concrete Construction.....	389
Laying Concrete under Water.....	256-258
Long Span Light Floor Construction.....	429
Modern Dock Construction.....	521
Modern Vs. Ancient Methods.....	251
Machine Vs. Hand Mixed Concrete.....	426
Notes on Concrete Construction.....	431
New Concrete Silo.....	21
Painting Concrete Structures.....	346
Proportioning Crushed Stone for Concrete.....	21
Proposed Specifications for Blocks.....	255
Preparation of Concrete.....	244
Reinforced Concrete Pipe.....	26
Ransome Concrete Dam.....	68
Rainbow Falls Concrete Dam.....	150-156
Roosevelt Dam.....	211
San Jose School.....	480
Salt Water Tests.....	440
Spokane Bridge.....	390
Sewer Construction.....	303
Tacoma Stadium.....	436
Transforming Frame Houses.....	290

PORTLAND CEMENT.

Another Use for Cement.....	160
Cement Combine.....	347
Coloring Cement.....	344
Cement Production in Canada.....	253
Cement in Washington and Oregon.....	248
Cement Trade with Foreign Countries.....	206
Cement Production in 1909.....	210
Exports of Cement to Latin America.....	206
Empty Cement Sacks.....	338
Fine Grinding of Cement.....	160
Freight Rates on Cement.....	392
Puzziolana Deposits.....	476
Railways use Cement Poles.....	160

**1910 GENERAL CEMENT MILLS
NEWS AND TRADE NOTES.**

Pages 22, 23, 62, 63, 64, 117, 118, 105, 164,
167, 212, 213, 215, 259, 260, 261, 305, 306, 347,
348, 349, 484, 529.

NEW CEMENT COMPANIES—1910.

Arkansas City Portland Cement Co.....	65
Arrowhead Cement Co.....	65
Alpha's new plant.....	213
Atlas Co.'s new plant.....	348
Ariz. Cement Co.....	482
Clinchfield Cement Co.....	118-394
Central Canada Cement Co.....	166-215
Colonial Cement Plant.....	214
Dakota Cement Co.....	348
Fairview Cement Co.....	348
Fort Dodge Cement Co.....	394
Gulf States Cement Co.....	394
Great Lakes Cement Co.....	24
Hercules Waterproof Co.....	215
Inland Cement Co.....	166
Knickerbocker Plant.....	529
Lehigh Co.'s new plant.....	348
Lake Shore Cement Co.....	167-214
Lily White Cement Co.....	213
Mobile Cement Co.....	65-348-478
Morgan Cement plant.....	214
New England plant.....	214
Oklahoma City Cement Co.....	24
People's Cement Co.....	24-213
Plant No. 6 U. S. Steel Co.....	64
Piedmont Cement Co.....	394
Rocky Mountain Cement plant.....	195
Standard Cement & Lime Co.....	24
St. Mary's Cement Co.....	166
Toreon, Mexico plant.....	213
U. S. Gypsum plant.....	213
Yellowstone Cement Co.....	394
White Cliff Cement Co.....	394

**DESCRIPTION OF CEMENT MILLS,
MACHINES, ETC.**

Allentown Cement Co.'s new mill.....	480
Adjustable Steel centers for Concrete Sewers	59-60
Air Separators in Cement Plants.....	48
Automatic Scales.....	116
Cement Paint for Steel.....	57
Concrete Railway Station, Waverly, Iowa	479
Cement Sewer Pipe.....	115
Concrete Products Plant in Iowa.....	259
Cement drain tile.....	250
Central Stone Co.'s plant.....	249
Detricks Clamp.....	250
Duval-Schubb System.....	346
Dodge Rope System.....	339
Dolese-Shepard plant.....	339
Excavator—A. Koppel Co.....	431
Fisher Block Machine.....	163
Ferro Double Headed Nails.....	249
Ft. Dodge Cement Mill.....	527
Helm Press.....	250
Jeffrey Flight Conveyor at N. Y. Show.	528
Koehring Mixer.....	205
Koehring Carrier.....	426
Miracle Steel Forms.....	66
New Giant Griffin Mill.....	25
Perfection Mixer.....	347
Ricketson Colors.....	67
Rickman's Sewer Bends.....	164
Riverside Cement plant.....	196-197
Rocky Mountain Cement plant.....	195
Republic Rubber Co.'s plant.....	477
Steam Turbines.....	216
Silica Brick and Stone.....	114
Utah Cement plant	519-521
Water Purification.....	116
Western Shaw-Block Machine.....	206
Water-Softener.....	216
Waterhouse, Illinois, Glass Co.....	478

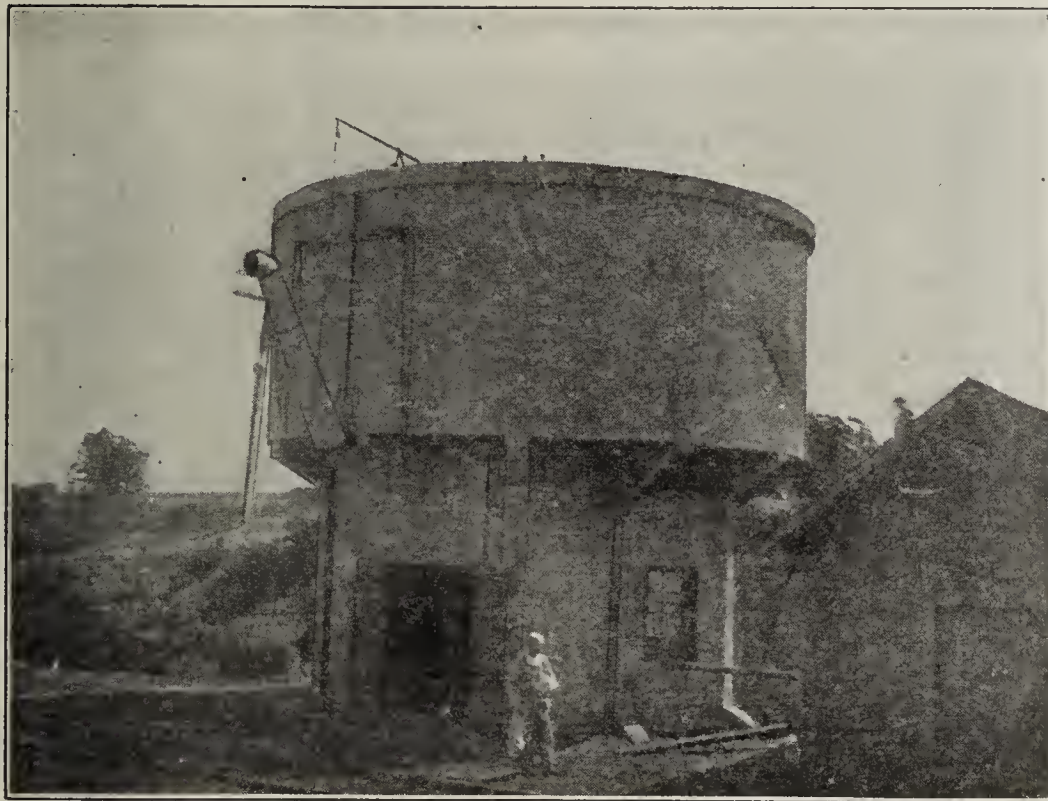
SPECIAL TECHNICAL ARTICLES.

Action of Sea Water on Cement.— By J. N. O'Hara.....	288
Advantage of Air Separators.—By D. E. Boydahn.....	198
Behavior of Hydraulic Compounds in Sea Water.—By Buchartz.....	421-424
Coloring Concrete, experiments.—By Pellew	427
Calcium Silicates and Calcium Alum- inates contained in Cement.—By Dr. O. Schott.....	372-515
Combustion in Cement Burning.—By Eldred	332-335
Cement for Protecting Piles in Sea Water	156
Development of Cement.—By Boyer.....	209
Effect of Alkali on Cement.....	378
Fan Blast in Cement Burning.—By Mangelsdorf	481
Fuel Requirements of Rotary Kiln.....	473
Fused Portland Cement.—By C. Unger	192, to 330
Gas Producers.—By Nesbet Lata.....	330-332
Gas Producers and Rotary Kilns.....	380-383
Hardening of Hydraulic Cements.....	47
Ideal Cement Specifications.—E. P. Goodrich	247
Making Concrete Water-proof.—Ira Baker	203
Plaster, Overburnt Gypsum and Hy- draulic Gypsum. — M. Glasenapp	50, to 148
Quartz Silica in Cement Mixture.—C. H. Sonntag.....	207
Resistance of Cement to Sea Water, How Increased, etc.—M. R. Feret.....	11-18
Report of Committee on Water- proofing	50-57
Sewer-gas Effect on Concrete.....	435
Slag Cement, mfr. and use.....	470-473
Unreliability of Cold Plunge test.— A. C. Davis.....	161
Utilization of blast furnace slag.—B. G. Waterhouse.....	7-10

CEMENT

... AND ...

ENGINEERING NEWS



A reinforced concrete tank for use in filling locomotive boilers with water. This was built on the line of the Atlantic & West Point Railroad and has been found entirely satisfactory. The space below the tank has been closed by means of light concrete curtain walls and is utilized as a store-room.

CEMENT AND ENGINEERING NEWS

(PUBLISHED MONTHLY)

WILLIAM SEAFERT, Editor and Publisher

OFFICE—22 Fifth Avenue
Cable Address -- "Seaferts" Chicago.Entered at the Post Office at Chicago, as Second-class matter, July 21, 1896
under Act of March 3d, 1879.Subscription. \$2.00 Per Year
Foreign Subscription. \$2.50 Per Year

Advertising Rates Sent on Application.

JOHN F. WALDRON Advertising Manager

Chicago, December 1910.

URIAH CUMMINGS.

With profound regret we announce the death of the Nestor of the American Cement Industry, Uriah Cummings, which occurred Nov. 11 at his home at Stamford, Conn., in his 78th year.

Mr. Cummings was one of the few American cement manufacturers of the old school. He manufactured cement for 40 years previous to the invention of the rotary furnace, at a time when the production of cement in this country was very small. Before and after the introduction of the rotary kiln process, he established several cement plants, in the management of which he took an active interest.

As scientist, lecturer or writer he was known almost to every man of the profession and was regarded as the highest authority in this country on any question relating to Natural cement. For many years he had charge of the investigations conducted by the United States government on this subject, and wrote the government reports which were published annually. He had a wide knowledge of the chemistry of cements, and his lecture on this topic, originally delivered at the Massachusetts Institute of Technology at Boston, in 1888, created a profound impression in scientific circles. He was a frequent contributor of articles on scientific subjects to technical magazines and other publications.

Aside from his authorship of technical works, Mr. Cummings wrote many tales, both historical and fanciful, dealing chiefly with the Indians of Western New York, in whom he was greatly interested.

He was a man of unusual accomplishments and of the highest standards of personal honor and integrity. He was widely read, and had constant correspondence on technical and historical subjects with distinguished men in America and abroad.

His scientific work was equally well accompanied by success as his business ventures. He made strong opposition to certain faulty theories and formulas advanced with the view to explaining the constitution of Portland cement and was lucky enough to see the day when his opponents had to admit the non-existence of a tri-calcium silicate and therewith the falsity of their assumptions.

He was just, dignified and courteous in his dealings with every one and proved his impartiality especially by the disdain in which he held those of his countrymen who were unwilling to give full credit to European scientists and who tried to introduce the brain work of foreigners, in re-written form, as their own mental productions.

His death, therefore, will be deplored by the American cement world as well as by his many foreign admirers.

THE CALCIUM SILICATES AND CALCIUM ALUMINATES CONTAINED IN PORTLAND CEMENT.

By Dr. O. Schott.

Translated by Dr. W. Michaelis, Jr.

(Continued from page 470)

THE CHEMICAL AND PHYSICAL PROPERTIES OF THE CALCIUM SILICATES: Before describing the chemical properties of the calcium silicates, I prefer to outline the various methods by means of which I tried to prove that really definite chemical compounds were obtained. During the last years it has been pointed out often enough that liquid reagents are not permissible for proving the existence or non-existence of uncombined calcium oxide, because the smallest amount of water suffices to decompose the calcium silicates into their component parts. In the same manner, alcoholic solutions, for instance of iodine, are of no avail, because, as Michaelis demonstrated, the acetic acid forming in the course of the reaction likewise leads to decomposition of the silicates. All methods employed for the determination of the uncombined lime, as for instance solutions of sugar or ammonium chloride or magnesium nitrate in alcohol led to widely differing results, so that to-day a number of experimenters believe no uncombined calcium oxide to be present in cement, while others assume up to 30% of lime to exist in the uncombined state in Portland cement.

Of late, even a more complicated theory has been advanced which assumes the calcium oxide to exist in three different forms, namely as combined, loosely combined and free calcium oxide. My efforts of proving the existence of free lime were directed towards combining it with gaseous anhydrous acids. For this purpose I employed sulphurous acid and carbonic acid which were dried by passing them through concentrated sulphuric acid and afterwards over calcium chloride. The reaction which I wished to obtain was based upon F. Schott's observation that calcium oxide, if heated to 500 centigrade, formed calcium sulphide and calcium sulphate in contact with gaseous sulphurous acid. The reaction was very lively; the calcium oxide began to glow at a single point and soon afterwards the whole mass was glowing. As this experiment required a comparatively low temperature, it could be made in combustion tubes as customary for the analysis of organic compounds. Before experimenting with burnt lime-silica mixtures, pure calcium oxide had to be tested at first. A platinum vessel containing a weighed quantity of freshly calcined chemically pure calcium oxide was, therefore, introduced into the combustion tube, both ends were closed with perforated stoppers and the tube was heated to 500 centigrade. The temperature was measured with a Le Chatelier pyrometer and could be easily maintained between 500 and 520 centigrade by regulating the gas supply. While the tube was heated, a current of dry sulphurous acid gas was passed through it. Every time, after glowing had been observed, the experiment was continued for another quarter of an hour and finally the increase of weight of the calcium oxide was determined.

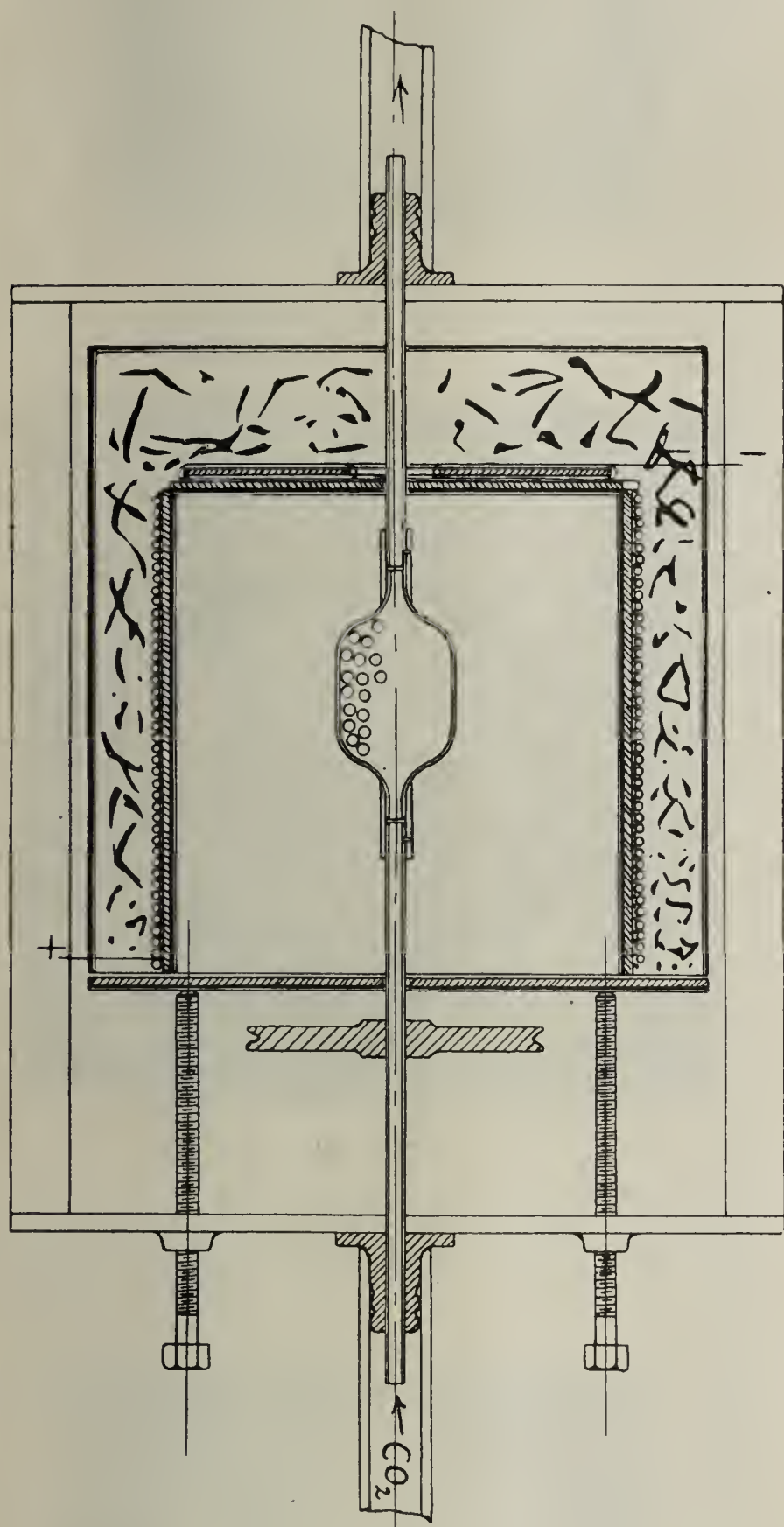
Three tests made in this way gave the following results, after passing sulphurous acid gas over the calcium oxide for 60 minutes:

I. Calcium oxide weighed off.....	1.0004 gram
Increase of weight.....	0.8328 gram

II. Calcium oxide weighed off..... 1.0002 gram
Increase of weight..... 0.6606 gram

III. Calcium oxide weighed off..... 1.0004 gram
Increase of weight..... 0.8436 gram

The reason why these results differed so much was found in the fact that a dense crust had formed on the surface of the substance, most likely as a consequence of the reaction, and that thus absorption of sulphurous acid was made difficult or entirely impossible for the calcium oxide underlying the crust.



No. 17.

The crust was broken with a platinum wire and powdered as much as possible. This enabled the calcium oxide again to combine with sulphurous acid gas upon renewed heating to 500 centigrade. After having been treated in the same way for another 60 minutes, the increase of weight was found to be 0.8636 and after an additional 30 minutes 0.8638.

A crust had formed again on the surface and made further combination with gas impossible, so that a quantitative determination of free lime by this method did not appear very promising.

Nevertheless, an application of this test to Portland cement, heated at 500 centigrade, was of some interest; 1.0000 gram of cement showed after 30 minutes an increase of 0.1507 gram. The substance was then pulverized and the experiment was repeated for three hours, when it showed an increase of 0.2146 gram.

Upon using carbonic acid gas instead of sulphurous acid the difficulty was found to be the same. The calcium carbonate forming on the surface prevented further excess of carbonic acid to the uncombined calcium oxide underneath. After many vain experiments, I constructed an apparatus which enabled the carbonic acid to have better access to the calcium oxide by rotating the powdered substance. This device (illustrated by cut No. 17) consisted of a furnace formed of an asbestos cylinder around which a spiral of nickel wire was laid through which a current of 10 amp. and 220 volt was passed. The nickel spiral was heated to red heat and thus enabled me to keep the inside of the cylinder at a constant temperature of 430 centigrade. Inside of this little furnace a glass bulb, 4 inches long, was kept rotating, attached at both ends to hollow brass tubes through which the carbonic acid passed in and out.

This device was further improved by inserting into the glass bulb a number of small glass balls which, analogous to a ball mill, thoroughly mixed the substance to be acted upon by the carbonic acid and increased its surface.

Yet, even by this method I did not succeed in completely transforming the calcium oxide into calcium carbonate in spite of passing carbonic acid through it for 24 hours. Each repetition of the experiment, although carried out under identically the same conditions, had a different result; under the most favorable conditions, 70% of the calcium oxide were converted into calcium carbonate. As the available literature on the subject showed that calcium oxide combined with carbonic acid only in the presence of water, I passed the carbonic acid through a wash bottle containing water. Now, the moist carbonic acid caused the calcium oxide to cake and to firmly adhere to the wall of the glass bulb, in spite of the glass balls rotating within it, which formed a renewed disturbance for the action of the carbonic acid upon it. Besides, in this latter form the experiment was utterly unfit for the determination of the uncombined calcium oxide in the burnt lime-silica mixtures, because the water certainly acted upon the calcium silicates as well as on the free lime and decomposed the former, so that the absorption of carbonic acid was no longer a criterion for the presence of uncombined calcium oxide. Hence, these experiments made with a view to determine the uncombined lime proved a failure like those of all my predecessors.

THE MONO-CALCIUM SILICATE: Its theoretical composition is:

CaO	48.28%
SiO ₂	51.72%

The composition of the fused products obtained by me was the following:

I. Raw Materials: Calcium carbonate and silica:
Burnt in an experimental furnace:

CaO	49.4%
SiO ₂	50.3%

II. Raw Materials: Calcium carbonate and silica:
Burnt in a large rotary kiln:

CaO	47.5%
SiO ₂	49.8%
Al ₂ O ₃ & Fe ₂ O ₃	2.5%

The alumina and iron oxide originated from the ashes of the fuel.

III. Raw Materials: Calcium sulphate and silica: Cooled slowly:

CaO	48.0%
SiO ₂	51.5%
Al ₂ O ₃ & Fe ₂ O ₃	0.2%

IV. Raw Materials: Calcium sulphate and silica: Glassy product:

CaO	47.9%
SiO ₂	51.6%

The glassy modification was amorphous, whereas all others possessed crystalline structure.

All these products were soluble in hydrochloric acid and formed gelatinous silica upon evaporation. Mixed with water and protected from the carbonic acid of the atmosphere none of them hardened. Pats placed under water were transformed into mud after 24 hours. Test pieces kept in air, however, hardened slowly, but did not exhibit any remarkable strength even after weeks. Also an admixture of 1 equivalent of calcium hydrate enabled it to harden but little.

In order to determine the water of hydration, one gram of each, of the finely pulverized glassy modification and of the crystalline product, were agitated several times a day with 10 ccm. of water in an air-tight glass vessel for 3 months. After this time a weighed-off quantity of the mono-calcium silicate was dried at 110 centigrade until the weight was found to be constant, and then the combined water was determined from the loss found after calcining over a blast lamp. The crystalline modification showed 2.7% and the glassy form 0.8% of water.

The crystalline modification showed pronounced swelling upon being agitated with water and was transformed into a voluminous precipitate. The volume was almost twice as large as before. It settled quickly to the bottom of the vessel after being disturbed, and the liquid on the top of it was always found to be perfectly clear. The hydrated mono-calcium silicate formed a solid cake upon being calcined over the blast lamp, which developed heat upon adding concentrated hydrochloric acid, but which did not dissolve completely. The water which was used in the process of hydration was evaporated; it left a small residue consisting of 0.2% of calcium oxide and a trace of silica.

THE DI-CALCIUM SILICATE: Both modifications of the di-calcium silicate, the stable form as well as the disintegrated, no matter from what raw materials they were produced, showed in every instance the characteristic properties which distinguished them. Both possessed a distinctly crystalline structure; however, the specific gravity of the stable form was 3.4, whereas that of the disintegrated modification was much lower, namely 3.15. This difference between the specific gravity of the two modifications and the transformation of the form of higher specific gravity into that of lower specific gravity, hence increased volume, explains the strange phenomenon of disintegration. As disintegrated modification was considered only that part which passed a 100-mesh sieve. If other investigators found a higher specific gravity for the disintegrated di-calcium silicate, they certainly overlooked the small particles of the stable form which were contained in it.

Both forms of the di-calcium silicate are soluble in hydrochloric acid and leave gelatinous silica upon evaporation. The principal characteristic distinguishing them is their behavior towards water. The disintegrated di-calcium silicate, mixed with 30% of water and kept in a dessiccator protected from the carbonic acid of the atmosphere, does not show signs of hardening even after several months, while, in the air, it

hardens slowly and develops low strength. The stable modification, however, sets within 8 hours and hardens fairly well, if placed under water after 24 hours. In the case of a pat made of disintegrated di-calcium silicate which actually hardened, it was discovered afterwards that it had not been sifted, that one-third of it consisted of small grains of the stable form and that the hardening was caused by this. After the remainder of the product was sifted through a 100-mesh sieve, it did not harden any more. The disintegrated modification mixed with 1 equivalent of calcium oxide hardened slightly in the air, but fell to pieces under water.

The water of hydration of the disintegrated form was determined in the same manner as that of the mono-calcium silicate by agitation of the fine powder with water for three months. It amounted to 7.19%. The water contained 0.12% calcium oxide in solution and likewise only a trace of silica.

The water of hydration of the stable form was determined by boiling of one gram of the finely powdered substance with 25 ccm. of water for 10 hours and subsequent weighing of the dried substance before and after calcination. It was found to be 9.8%.



No. 18.

THE TRI-CALCIUM SILICATE: Also in the case of the "tri-calcium silicate" a distinction has to be made between a disintegrated and a stable modification. Both were formed in the burning process at the same time; however, the disintegrated part was always in excess. The specific gravity of the stable form was 3.25, and that of the disintegrated portion only 2.91. Both were soluble in hydrochloric acid and left gelatinous silica upon evaporation.

The disintegrated "tri-calcium silicate" had the following composition:

FOUND:		CALCULATED:	
CaO	73.1%	CaO	73.3%
SiO ₂	25.9%	SiO ₂	26.7%
Al ₂ O ₃ & Fe ₂ O ₃	0.5%		

Gauged with 30% of water, it did not harden, if protected from carbonic acid. Even after 4 weeks, the thumb-nail left an impression. The stable "tri-calcium silicate," on the other hand, set after 8 hours without generating much heat. The next day, however, hence after 24 hours, fissures appeared; one of the pats was placed under water after this time, while another was left in a dessiccator in a moist atmosphere. The process of expansion could be seen to grow

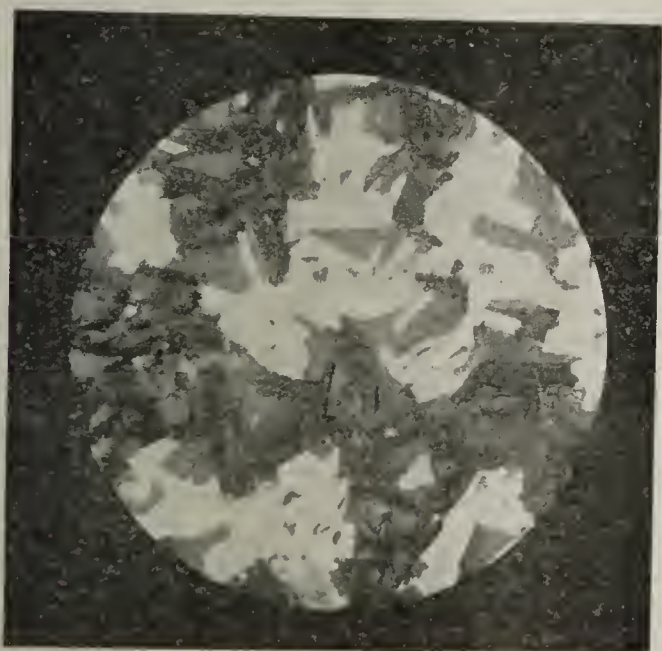


No. 19.

rapidly. After two days, the pat kept in air showed a great number of cracks and two small balls were likewise destroyed by blowing. (See cut No. 18) The pat placed under water fell completely to pieces within two days and was transformed into a mud soon afterwards.

These tests should have been sufficient to prove that a "tri-calcium silicate" can not be present in Portland cement, on account of the pronounced process of expansion following the mixing with water. Furthermore, it illustrates that a "tri-calcium silicate" does not exist, but represents merely a fused mixture in the molecular proportions 3CaO to 1SiO_2 which contains free lime in addition to a chemical compound. This deduction follows likewise from Le Chatelier's theory according to which blowing or expansion is a sure sign of the presence of uncombined calcium oxide.

Several especially well fused pieces were pulverized and exposed to the air for a week. Then a pat was made with 30% of water, which was protected from the action of the carbonic acid upon it. The pat hardened, but developed small cracks after 24 hours. When placed under water, the fissures grew in size so that the pat threatened to go to pieces; therefore, it was taken out of the water again and placed in a moist atmosphere, in which the cracks still continued to grow in size and in number. After four weeks, the pat appeared dried out; it could be broken to pieces by the slightest pressure of the finger, hence did not show any signs of hardening.



No. 20.

The water of hydration was found to amount to 15.7% after three months. The water which served for the hydration was perfectly clear; it was found to contain in solution 0.12% of calcium oxide and only a trace of silica. The hydrated powder, upon being dried for 4 hours at 110 centigrade in an air current free of carbonic acid, was found to be distinctly crystalline, most likely owing to the formation of crystals of calcium hydrate. These crystals disappeared upon calcination.

$2.5\text{CaO}, 1\text{SiO}_2$: The fused product originating from a mixture of calcium oxide and silica in these proportions occurred also in two forms, a disintegrating and a stable modification. The specific gravity of the former was 3.18, that of the latter 3.26, hence almost identically the same as that of the stable "tri-calcium silicate." Also in the case of this preparation the disintegrated part does not harden, while the stable form, upon pulverizing and mixing with 30% of water, hardens after 6 hours, and obtains considerable strength within 24 hours. If placed in water after 24 hours, it hardens better than the di-calcium silicate; however, one of the pats showed small expansion cracks after a week, while another was slightly curved (see cut No. 19.) After three months, the fissures were not found to have increased in size and the pats had obtained great strength under water. A ball made from the same material was perfectly sound. A third pat, made later, likewise showed slight curving, but hardened well. The glass plate was covered with crystals, shown by cut No. 20. A part of the fused product was exposed to the air for a week and then made into pats. In this case, it did not show the least sign of blowing even after three months. Thus, the lowest limit of expansion seems to be at this point. The small percentage of free lime is hydrated by exposure to the air in the same way as Portland cement becomes sound by curing in a moist atmosphere.

CALCIUM ALUMINATES:

As it was an open question, whether or not calcium aluminates were contained in Portland cement, I had to prepare them in proportions analogous to the fused lime-silica mixtures to study their chemical and physical properties.

Alumina acts the part of a feeble acid in contact with strong bases and consequently forms aluminates, if fused together with calcium oxide. Such mixtures are more easily fusible than the corresponding calcium silicates and can be prepared on a small scale in platinum vessels at temperatures between 1400 and 1500 centigrade. Hereby it is surprising to observe that the high-limed mixtures fuse at the lowest temperature, whereas the reverse is true of the ferrites, which will be described in a later chapter.

On account of the low melting point of the aluminates I believed to be able to burn large quantities of them in the small rotary furnace illustrated by cut No. 10. Yet, the aluminates proved to possess so great an affinity for carbon, with which they formed apparently a mixture of aluminum carbide and calcium carbide, that in every instance only a bluish-black product was obtained in spite of the greatest precautions to prevent the carbon particles from coming in contact with the fused product. The dark color was found to extend uniformly throughout the mass; in a pulverized state the product appeared green. A mono-calcium aluminate obtained in this manner set only after 4 hours and was of a dark-green color; it hardened well. However, even after several months the pats smelled still strongly of hydro-carbons.

THE MONO-CALCIUM ALUMINATE: Mixtures of calcium carbonate and alumina in equimolecular proportions were moulded into massive cylinders, 6 inches high and 2 inches in diameter, and burnt in furnace No. 14, 15. The cylinder began to melt at the top as a rule; from the time when fusing set in at this point, the whole cylinder generally melted in a minute. In cases, in which the heat supply was not interrupted in time, it happened, therefore, that the whole mass was transformed into a thin liquid and flowed out of the furnace. The fused product was faintly green, most likely caused by the 0.3% of iron oxide contained in it. The composition was the following:

FOUND:		CALCULATED:	
CaO	35.2%	CaO	35.5%
Al ₂ O ₃	64.1%	Al ₂ O ₃	64.5%
Fe ₂ O ₃	0.3%		

The fused substance was very hard, so that it required a considerable effort to pulverize it. The powdered substance was white. Its specific gravity was 2.91. A microscopic section made from the fused substance showed a distinctly crystalline structure.

Gauged with 30% of water, a thin paste resulted which could be handled easily. However, after 5 minutes the pats had set hard and could be placed under water. After a few days they were as hard as a rock and possessed translucent edges resembling marble. However, in time the surface became soft again in the same way as with pats made of gypsum.

The water of hydration was determined again by agitating six times a day one gram of the finely pulverized product with 10 ccm. of water for three months. Samples which were not agitated continuously for the first days hardened over night. The increase of volume caused by hydration burst the glass in one instance and made the water flow out. The water of combination was found to be 23.2%.

THE DI-CALCIUM ALUMINATE: This product proved to be very dense and resembled ivory; it was so hard that it was impossible to pulverize it in a porcelain mortar with a porcelain pestle. The melting temperature was 1450 centigrade. The microscope plainly revealed also in this case crystals. Its specific gravity was 2.8. Mixed with 30% of water, the powdered substance set so fast that, in spite of lively stirring, small grains were formed which could be broken only with difficulty. Alone by making use of more water, namely 40%, and very quick stirring, a pat could be obtained, which set as soon as deposited on the glass plate and which was found to harden very well, after being placed under water when 24 hours old, without exhibiting signs of blowing.

The water of hydration taken up within 3 months was 28.2%. Although this compound set faster than the mono-calcium aluminate and, for this reason, had to be agitated continuously in the beginning, it showed only slight inclination to harden, after having been agitated with water for 8 hours, and was unable to harden after this process had been continued for another ten hours.

To be true, some particles had combined and formed lumps; however, these could be easily separated with a platinum wire. While the liquid became clear after a short time in the case of the silicates, the same did not occur with the aluminates. Even if allowed to settle for 24 hours, a white milky suspension was left in the liquid over the powder which settled at the bottom and the hydrated substance, in opposition to the calcium silicates, had increased its volume only slightly.

TRI-CALCIUM ALUMINATE: This fused as low as 1400 centigrade and formed a dense gray substance of the specific gravity of 2.88. Under the microscope crystals could readily be discerned. When gauged with water, it showed exactly the same properties as the di-calcium aluminate, that is to say it hardened at once. Placed under water after 24 hours, it began to



No. 21.

blow in a short time and disintegrated after two days (see cut No. 21.)

After having been agitated with water for three months, 34% of water of combination were found. Also in this case the water was found not to be clear, but it contained a milky suspension.

2.5CaO, 1Al₂ O₃: In accordance with the 2.5CaO, 1SiO₂ which furnished the lime-limit in the case of the silicates, I prepared an analogous fused mixture from calcium oxide and alumina. This fused at 1450 centigrade. Mixed with water, it hardened immediately and showed no signs of blowing for a week, if placed under water 24 hours after being made, although the pats had come off the glass plates. After two weeks, however, slight curving could be observed, which became more pronounced after an additional lapse of two weeks. These faint signs of blowing disappeared entirely upon exposure of the finely powdered substance to the air. Now, the pats were found to firmly adhere to the glass after 4 weeks without showing the least sign of blowing. Hence, the highest lime-limit, in the case of the aluminates, corresponds likewise with the ratio 2.5CaO, 1Al₂ O₃; beyond these proportions the product becomes unsound.

CALCIUM FERRITES:

The calcium ferrites were produced mainly with a view to ascertain whether they have to be regarded as hydraulic substances or whether the iron oxide contained in cements has merely to be considered an adulteration. The opinions on this subject are divided and a comprehensive literature has developed in the course of time on the question, whether the iron oxide has to be regarded of the same value as the alumina and has to be included in the calculations. If calcium ferrites

exist possessing hydraulic properties, it must be assumed that these form in the burning process of cements; however, it is even more likely that the iron oxide, in the same way as the alumina, combines with the calcium silicates to "double compounds."

For the preparation of the mono-calcium ferrite I used again gypsum which was mixed with iron oxide in equimolecular proportions and fused in an electric furnace. Fumes of sulphuric acid and an odor of sulphurous acid became noticeable at 900 centigrade. At 1200 centigrade the mass melted down to a thin liquid which assumed a crystalline structure upon being taken out of the furnace. The di-calcium ferrite and tri-calcium ferrite fused only at 1500 and 1530 centigrade. All these fused products were of a black-brown color; the powder resulting from them was the lighter the higher the contents of lime were. The mono-calcium ferrite, gauged with 30% of water, set after 6 hours. The di-calcium ferrite hardened after exactly the same time. The tri-calcium ferrite, however, set at once and was perfectly hard after 10 minutes. It developed considerable heat during hardening. All pats were placed under water after 24 hours. After two days, the mono-calcium ferrite and di-calcium ferrite had gained considerable strength, whereas the tri-calcium ferrite had increased its volume, showed many cracks and was found to be softened completely (see cut No. 22.)

In the same manner as the former products, these three ferrites were pulverized and hydrated completely for three months. In spite of repeated agitation, the mono-ferrite and di-ferrite were inclined to harden during the first days.

After three months, the liquid was yellow in the case of the mono-calcium ferrite, orange-colored with the di-calcium ferrite and milky white for the tri-calcium ferrite.

The mono-calcium ferrite had combined with 4.9% of water, the di-calcium ferrite with 18.7% and the tri-calcium ferrite with the 19.9%.



No. 22.

DOUBLE COMPOUNDS OF CALCIUM OXIDE, SILICA AND ALUMINA:

As alumina has a strong tendency to form double compounds, we may assume that the latter exist also in cements and consequently have to look especially for compounds capable of combining with a maximum of calcium oxide.

Nature provides a number of such double compounds, as for instance:

Melilite: $1\text{SiO}_2, 0.2\text{Al}_2\text{O}_3, 1.3\text{CaO}$

Idocrase: $1\text{SiO}_2, 0.25\text{Al}_2\text{O}_3, 1\text{CaO}$

Gehlenite: $1\text{SiO}_2, 0.5\text{Al}_2\text{O}_3, 1.5\text{CaO}$

Also several other facts indicate that cements contain "double compounds." Thus Unger discovered well-formed crystals in fused cements which contained calcium oxide, silica and alumina. The contents of sesqui-oxides in these crystals were always between 6% and 10%. Also the grappiers, which Le Chatelier mistook for a tri-calcium silicate, in spite of a considerable percentage of alumina, point towards the existence of double compounds.

Le Chatelier published four analyses of the grappiers, in which the sum of the alumina and iron oxide amounted to between 3.5% and 4.3%. He did not assume any calcium oxide to be combined with the sesqui-oxides, but figured the total amount of lime as being in combination with silica. In this way he managed to find calcium oxide and silica to be present approximately in the proportion of 3 to 1.

My observations, on the contrary, compel me to declare a tri-calcium silicate, tri-calcium aluminate or tri-calcium ferrite to be out of the question in a cement, because these three fused products go to destruction in contact with water on account of expansion. The safe limit is represented by the ratio $2.5\text{CaO}, 1\text{SiO}_2$ or $2.5\text{CaO}, 1\text{Al}_2\text{O}_3$.

On the other hand, practical experience shows that the quality of a Portland cement is the better the more lime it contains. However, an excess of only one percent of calcium oxide above the limit of safety becomes the cause of blowing. Hence, the manufacturer must endeavor to reach this limit and yet not to surpass it. The product $2.5\text{CaO}, 1\text{SiO}_2$ answers these requirements exactly. In the case of the grappiers, the ratio of calcium oxide to silica is close to 3 to 1, to be true. But it has been mostly overlooked that the grappiers contain from 3.5% to 4.2% of alumina and iron oxide which are combined with part of this calcium oxide.

This small percentage of alumina and iron oxide is not sufficient to combine all of the calcium oxide contained in the grappiers beyond the proportions $2.5\text{CaO}, 1\text{SiO}_2$, if the ratio of calcium oxide to alumina or iron oxide in these combinations is assumed to be likewise 2.5 to 1. This explains why the grappiers, which are obtained as non-slaking nodules in the slaking process of the calcined hydraulic lime from Teil, have to be exposed to the air for many months, namely in order to make the surplus of lime combine with the moisture and carbonic acid of the atmosphere. Only after this curing process has taken place, a sound Portland cement can be manufactured from them.

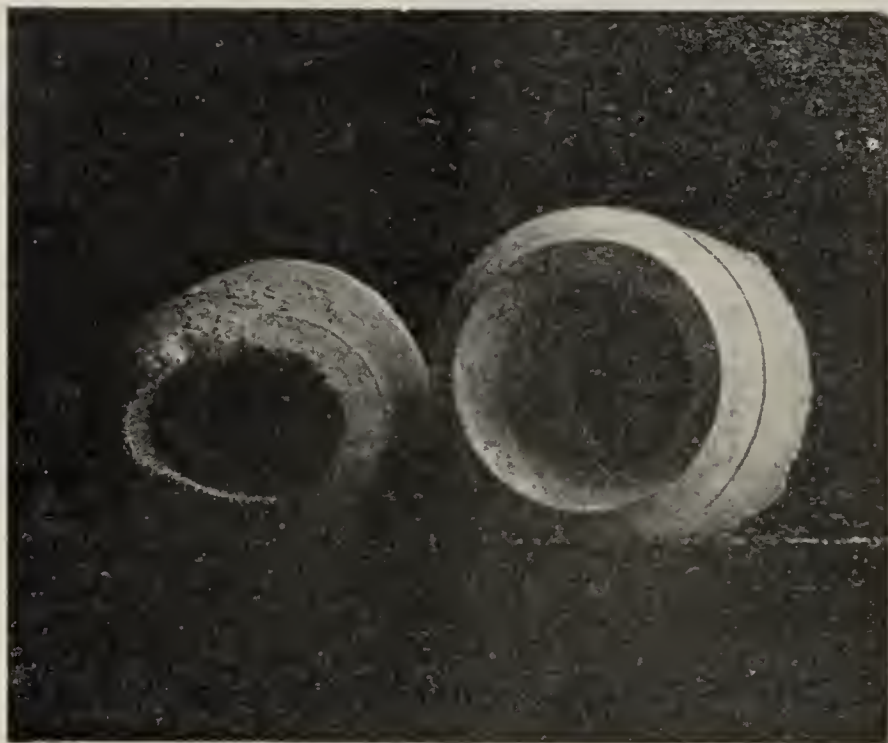
I prepared mixtures of calcium oxide and silica in the proportion of 3 to 1 and added to these varying amounts of alumina. These were burnt in the electric furnace No. 11, 12. The composition of the vitrified products was the following:

	No. 1.	No. 2.	No. 3.	No. 4.
Silica	25.2%	24.9%	24.0%	23.2%
Alumina	4.2%	5.0%	7.1%	8.5%
Calcium Oxide.....	70.1%	69.7%	68.3%	68.5%

Mixture No. 1, containing 4.2% of alumina, fused as

low as 1600 centigrade, whereas the preparation $3\text{CaO}, 1\text{SiO}_2$ required a temperature above 2000 centigrade. Upon gradually increasing the percentage of alumina, the melting temperature of the mixture went down to 1500 centigrade.

Besides, the admixture of alumina stopped the disintegrating of the burnt product and enabled the hollow cylinders to vitrify and fuse uniformly throughout, as cut No. 23 illustrates which shows a cylinder after being burnt and before being exposed to the heat.



No. 23.

The porcelain-like fused products were ground and resulted in perfectly white cements. Gauged with 30% of water, No. 1 began to set after 2 hours and had finished setting after 8 hours. The following day, the pats were submerged in water and proved to be sound for the first days. However, after 3 days No. 1 showed fissures and slight curving of the test piece. After a week, the fissures had increased a little; but from this time on, no further signs of blowing became noticeable, so that the pat became very hard in time, in opposition to the test pieces of "tri-calcium silicate" formerly described.

Upon being exposed to the air for a week, the powdered product was found to be perfectly sound and required less water to obtain the same consistency. Cut No. 24 shows pats made of this cement before being seasoned and after exposure to the air. Hence, an admixture of 4.2% of alumina to the tri-calcium silicate mixture suffices to give the product entirely different properties. The fused tri-calcium silicate was unsound even after having been exposed to the air for a month and did not harden under water at all, whereas the behavior of the fused product containing 4.2% of alumina corresponded in every respect with that of the grappiers. The test pieces made from the other three products, with 5.0%, 7.1% and 8.5% of alumina, hardened well from the very beginning and remained sound.

The tri-calcium aluminate and tri-calcium ferrite, upon exposure to the air, fell gradually to pieces, as cuts No. 25 and No. 26 show in which the solid crust surrounding the fused piece is seen to burst. Subsequently it increased its volume and crumbled to dust.

The disintegrated tri-calcium aluminate showed a loss at red heat of 2.45% and the tri-calcium ferrite even 8.55%.

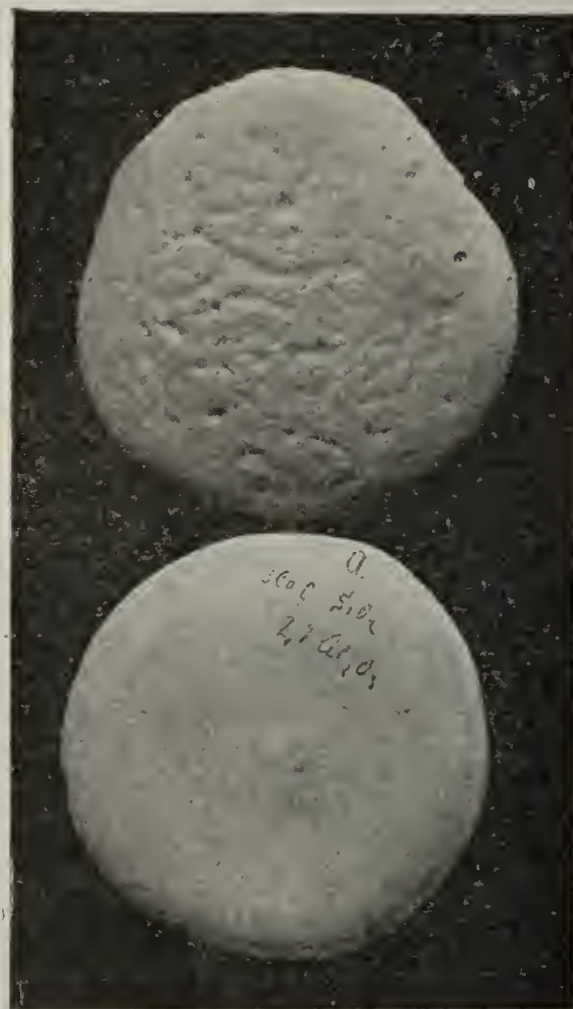
In order to prove whether "double-compounds" are contained in Portland cement or whether it represents

a mixture of four different compounds which latter, according to Toernebohm's observation, is more likely to be the case, it becomes necessary to investigate, if products of different properties result if, in the first place, two simple compounds, each of which has been fused and been powdered separately, are mixed together; and if, in the second place, a mixture of the same raw materials and same composition is prepared and fused in one operation.

For this reason, a mixture of 4 parts of fused $2.5\text{CaO}, 1\text{SiO}_2$ and 1 part of fused $2.5\text{CaO}, 1\text{Al}_2\text{O}_3$ was compared with a former product of the same composition obtained by simultaneous fusion of all ingredients. The composition of these cements was as follows:

FUSED SIMULTANEOUSLY:		MIXTURE OF TWO FUSED PRODUCTS:	
CaO	68.2%	CaO	67.6%
Al_2O_3	8.5%	Al_2O_3	8.4%
SiO_2	23.7%	SiO_2	23.9%

Both products, upon being mixed with 30% of water, set between 7 and 8 hours. Tensile strength briquettes made from them with 3 parts of standard testing sand set both at the same time, after about 8 hours. However, although ground to the same fineness, the mixture of two separate compounds showed a tensile strength of 420 lbs. per sq. in. after 28 days, while the product resulting from simultaneous fusion of all ingredients yielded 610 lbs.

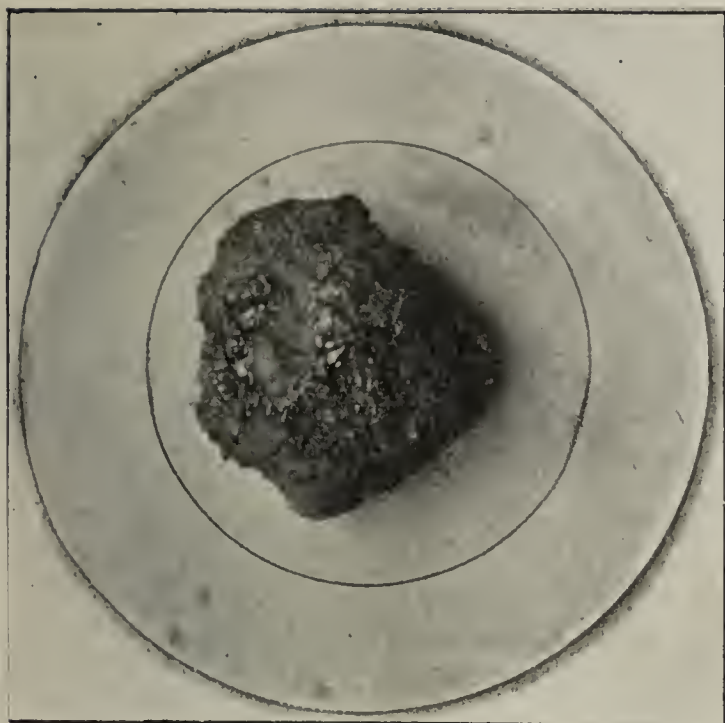


No. 24.

HYDRAULIC PROPERTIES:

While all former investigators were able to study the hydraulic properties of their synthetically prepared compounds only in a very superficial way at small test pieces, I was in a position to make briquettes of standard size from them in mixtures of 1 cement to 3 sand and to determine their strength after submersion in water for 28 days.

For this purpose, 40 grams of each cement, powdered so finely as to pass a 200-mesh sieve, were mixed



No. 25.

with 120 grams of standard testing sand and 8% of water and moulded into a briquette; after 24 hours this was submerged in 40 liters of water.

As the pats made from the tri-calcium silicate mixture were unsound, the briquette corresponding with it was placed on a watch glass and then submerged in water.

The observations made during the hardening were the following:

As formerly mentioned, the mono-calcium silicate possessed no hydraulic properties. The di-calcium silicate and the fused product resulting from a mixture in the proportion of 2.5CaO to 1SiO_2 hardened without showing any features of importance, especially without clouding of the water. The briquette made of tri-calcium silicate possessed large fractures after several days and had increased its volume considerably.

Unfortunately, the tri-calcium aluminate was not placed on a watch glass and consequently fell to pieces after a few days and was completely destroyed in time. The other aluminates hardened well and caused clouding of the water; the briquettes were soon covered with a voluminous colloidal precipitate, which proved to be alumina hydrate, while the water contained calcium hydrate in solution.

Also the tri-calcium ferrite went to pieces on account of expansion, while the mono-calcium ferrite and di-calcium ferrite hardened without developing any

noteworthy features with the exception of giving off calcium hydrate to the surrounding water.

Furthermore, briquettes were made of the products described in the last chapter, namely of admixtures of alumina to tri-calcium silicate mixtures. Also the hardening of these latter products did not show anything extraordinary. The water remained clear.

The result of these tensile strength tests after 28 days was the following:

$1\text{CaO}, 1\text{SiO}_2$	.....	no hardening.
$2\text{CaO}, 1\text{SiO}_2$	.....	150 lbs. per sq. in.
$2.5\text{CaO}, 1\text{SiO}_2$	.....	390 lbs. per sq. in.
$3\text{CaO}, 1\text{SiO}_2$	.....	fell to pieces.
$1\text{CaO}, 1\text{Al}_2\text{O}_3$	.....	795 lbs. per sq. in.
$2\text{CaO}, 1\text{Al}_2\text{O}_3$	.....	315 lbs. per sq. in.
$2.5\text{CaO}, 1\text{Al}_2\text{O}_3$	.....	105 lbs. per sq. in.
$3\text{CaO}, 1\text{Al}_2\text{O}_3$	.....	fell to pieces.
$1\text{CaO}, 1\text{Fe}_2\text{O}_3$	.....	120 lbs. per sq. in.
$2\text{CaO}, 1\text{Fe}_2\text{O}_3$	.....	75 lbs. per sq. in.
$3\text{CaO}, 1\text{Fe}_2\text{O}_3$	.....	fell to pieces.
$3\text{CaO}, 1\text{SiO}_2$ plus 4.2% Al_2O_3	.....	585 lbs. per sq. in.
$3\text{CaO}, 1\text{SiO}_2$ plus 5.0% Al_2O_3	.....	535 lbs. per sq. in.
$3\text{CaO}, 1\text{SiO}_2$ plus 7.1% Al_2O_3	.....	525 lbs. per sq. in.
$3\text{CaO}, 1\text{SiO}_2$ plus 8.5% Al_2O_3	.....	615 lbs. per sq. in.

This shows that with the silicates the strength increases with the growing percentage of lime, whereas in the case of the aluminates and ferrites the strength decreases.

The extraordinarily high strength of the mono-calcium aluminate is especially noteworthy. It amounted to 795 lbs., while Portland cement in mixtures of 1 cement to 3 sand gives seldom a higher strength than 450 lbs. Also the fused mixtures with from 4.2% to 8.5% of alumina showed much higher strength than the pure silicates. In this connection it may be stated that the crystals observed by Unger in his fused cements likewise contained from 4% to 9% of alumina.

THE CHICAGO BUILDING CODE.

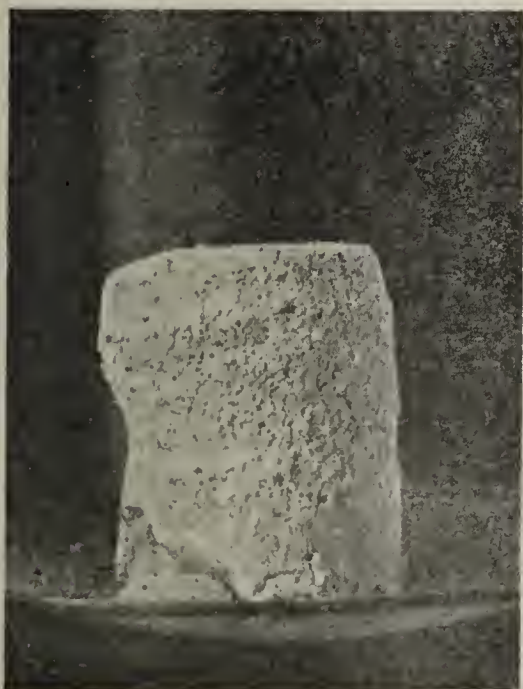
The Building Ordinances of the City of Chicago have been carefully revised during the past five years, so that the ordinances as now proposed are, in many instances, entirely different from the code in force since 1905.

This is especially true of the building regulations relating to concrete construction which, up to this time, were very brief and incomplete.

In the following we publish the new paragraphs covering reinforced concrete construction which are now being discussed by the Western Society of Engineers prior to their final acceptance.

The outcome of the present endeavors in this line we hope will be a code which safeguards concrete construction as far as this can be accomplished by human efforts and which will be accepted in time as a standard throughout the country.

545. **Reinforced Concrete—Definition—Plans.)** The term "Reinforced Concrete" means any combination of metal imbedded in concrete to form a structure so that the two materials assist each other to sustain all the stresses imposed. Before a permit to erect any reinforced concrete structure is issued, complete plans and specifications shall be filed with the Commissioner of Buildings, showing all details of the construction, including detail of working joints, the size and position of all reinforcing rods, stirrups or other forms of metal, and giving the composition and proportion of



No. 26.

the concrete; provided, however, that permission to erect any reinforced concrete structure does not in any manner approve the construction until after tests have been made of the actual construction to the satisfaction of the Commissioner of Buildings.

546. Ratio of Moduli of Elasticity—Adhesion—Bond.) (a) The calculations for the strenght of reinforced concrete shall be based on the assumed ultimate compressive strength per square inch designated by the letter "U" given in the table below for the mixture to be used.

(b) The ratio designated by the letter "R" of the modulus of elasticity of steel to that of the different grades of concrete shall be taken in accordance with the following table:

Mixture.	U	R
1 cement, 1 sand, 2 broken stone, gravel or slag.....	2,900	10
1 cement, 1½ sand, 3 broken stone, gravel or slag....	2,400	12
1 cement, 2 sand, 4 broken stone, gravel or slag....	2,000	15
1 cement, 2½ sand, 5 broken stone, gravel or slag....	1,750	18
1 cement, 3 sand, 7 broken stone, gravel or slag....	1,500	20

547. Unit Stresses for Steel and Concrete.) (a) The stresses in the concrete and the steel shall not exceed the following limits:

(b) Tensile stress in steel shall not exceed one-third of its elastic limits and shall not exceed 18,000 pounds per square inch.

(c) Shearing stress in steel shall not exceed 12,000 pounds per square inch.

(d) The compressive stress in steel shall not exceed the product of the compressive stress in the concrete multiplied by the elastic modulus of the steel and divided by the elastic modulus of the concrete.

(e) Direct compression in concrete shall be one-fifth of its ultimate strength. Bending in extreme fibre of concrete shall be thirty-five one-hundredths of the ultimate strength.

(f) Tension in concrete on diagonal plane shall be one-fiftieth of the ultimate compressive strength.

(g) For a concrete composed of one part of cement, two parts of sand, four parts of broken stone, the allowable unit stress for adhesion per square inch of surface of imbedment shall not exceed the following:

	Pounds Per Sq. Inch.
On plain round or square bars of structural steel.....	70
On plain round or square bars of high carbon steel....	50
On plain flat bars, in which the ratio of the sides is not more than 2 to 1.....	50
On twisted bars when the twisting is not less than one complete twist in eight diameters.....	100

(h) For specially formed bars, the allowable unit stress for bond shall not exceed one-fourth of the ultimate bond strength of such bars without appreciable slip which shall be determined by tests made by the person, firm or corporation to the satisfaction of the Commissioner of Buildings, but provided that in no case shall such allowable unit stress exceed 100 pounds per square inch of the specially formed bars.

548. Design for Slabs, Beams and Girders.) Reinforced concrete slabs, beams and girders shall be designed in accordance with the following assumptions and requirements:

(a) The common theory of flexure shall be applied to beams and members resisting bending.

(b) The adhesion between the concrete and the steel shall be sufficient to make the two materials act together.

(c) The steel to take all the direct tensile stresses.

(d) The stress strain curve of concrete in compression is a straight line.

(e) The ratio of the moduli of elasticity of concrete to steel shall be as specified in the table in Section 546.

549. Moments of External Forces.) (a) Beams, girders, floor or roof slabs and joists shall be calculated as supported, or with fixed ends, or with partly fixed ends, in accordance with the actual end conditions, the number of spans and the design.

(b) When calculated for ends partly fixed for intermediate spans with an equally distributed load where the adjacent spans are of approximately equal lengths:

Bending moment at center of spans shall not be less than that expressed in the formula $\frac{WL^2}{12}$ for inter-

mediate spans and $\frac{WL^2}{10}$ for end spans.

(c) The moment over supports shall not be less than the formula $\frac{WL^2}{18}$ and the sum of the moments

over one support and at the center of span shall be taken not less than the formula $\frac{WL^2}{6}$.

In the formula hereinabove given "W" is the load per lineal foot and "L" the length of span in feet.

(d) In case of concentrated or special loads the calculations shall be based on the critical condition of loading.

(e) For fully supported slabs, the free opening plus the depth, for continuous slabs, the distance between centers of supports, is to be taken as the span.

(f) Where the vertical shear, measured on the section of a beam or girder between the centers of action of the horizontal stresses, exceeds one-fiftieth of the ultimate direct compressive stress per square inch, web reinforcement shall be supplied sufficient to carry the excess. The web reinforcement shall extend from top to bottom of beam, and loop or connect to the horizontal reinforcement. The horizontal reinforcement carrying the direct stresses shall not be considered as web reinforcement.

(g) In no case, however, shall the vertical shear, measured as stated above, exceed one-fifteenth of the ultimate compression strength of the concrete.

(h) For T beams the width of the stem only shall be used in calculating the above shear.

(i) When steel is used in the compression side of beams and girders, the rods shall be tied in accordance with requirements of vertical reinforced columns with stirrups connecting with the tension rods of the beams or girders.

(j) All reinforcing steel shall be accurately located in the forms and secured against displacement; and inspected by the representative of the architect or engineer in charge before any surrounding concrete be put in place. It shall be afterwards completely inclosed by the concrete, and such steel shall nowhere be nearer the surface of the concrete than 1½-inch for columns, 1½-inch for beams and girders, and ½-inch, but not less than the diameter of the bar, for slabs.

(k) The longitudinal steel in beams and girders shall be so disposed that there shall be a thickness of concrete between the separate pieces of steel of not less than one and one-half times the maximum sectional dimension of the steel.

(l) For square slabs with two-way reinforcements

the bending moment at the center of the slab shall not be less than that expressed in the formula $\frac{WL^2}{24}$ for intermediate spans, and $\frac{WL^2}{20}$ for end spans.

(m) The moment over supports shall not be less than the formula $\frac{WL^2}{36}$ and the sum of the moments over one support and at the center of the span shall be taken not less than the formula $\frac{WL^2}{12}$.

In which above formula "W" is the load per lineal foot and "L" the length of the span.

(n) For squares or rectangular slabs, the distribution of the loads in the two directions, shall be inversely as the cubes of the two dimensions.

(n) For squares or rectangular slabs, the distribution of the loads in the two directions, shall be inversely as the cubes of the two dimensions.

(o) Exposed metal of any kind will not be considered a factor in the strength of any part of any concrete structure, and the plaster finish applied over the metal shall not be deemed sufficient protection unless applied of sufficient thickness and so secured as to meet the approval of the Commissioner of Buildings.

550. Limiting Width of Flange in "T" Beams.)

(a) In the calculation of ribs, a portion of the floor slab may be assumed as acting in flexure in combination with the rib. The width of the slab so acting in flexure is to be governed by the shearing resistance between the rib and slab, but limited to a width equal to one-third of the span length of the ribs between supports and also limited to a width of three-quarters of the distance from center to center between ribs.

(b) No part of the slab shall be considered as a portion of the rib, unless the slab and rib are cast at the same time.

(c) Where reinforced concrete girders support reinforced concrete beams, the portion of floor slab acting as flange to the girder must be reinforced with rods near the top, at right angles to the girder, to enable it to transmit local loads directly to the girder and not through the beams.

551. Shrinkage and Thermal Stresses.) Shrinkage and thermal stresses shall be provided for by introduction of steel.

552. Reinforced Concrete Columns — Limit of Length—Per Cent of Reinforcement—Bending Moment in Columns—Tying Vertical Rods.) (a) Reinforced concrete may be used for columns in which the concrete shall not be leaner than a 1:2:4 mixture and in which the ratio of length to least side or diameter does not exceed twelve, but in no case shall the cross section of the column be less than 64 square inches. Longitudinal reinforcing rods must be tied together to effectively resist outward flexure at intervals of not more than twelve times least diameter of rod and not more than 18 inches. When compression rods are not required, reinforcing rods shall be used, equivalent to not less than one-half of one per cent (.005) of the cross-sectional area of the column; provided, however, that the total sectional area of the reinforcing steel shall not be less than one square inch, and that no rod or bar be of smaller diameter or least dimensions than one-half inch. The area of reinforcing compression rods shall be limited to three per cent of cross sectional area of the column.

Vertical reinforcing rods shall extend upward or downward into the column, above or below, lapping the reinforcement above or below enough to develop the stress in rod by the allowable unit for adhesion. When beams or girders are made monolithic with or rigidly attached to reinforced concrete columns, the latter shall be designed to resist a bending moment equal to the greatest possible unbalanced moment in the beams or girders at the columns, in addition to the direct loads for which the columns are designed.

(b) When the reinforcement consists of vertical bars and spiral hooping, the concrete may be stressed to one-fourth of its ultimate strength as given in Section 546, provided, that the amount of vertical reinforcement be not less than the amount of the spiral reinforcement, nor greater than eight per cent of the area within the hooping; that the percentage of spiral hooping be not less than one-half of one per cent nor greater than one and one-half per cent; that the pitch of the spiral hooping be uniform and not greater than one-tenth of the diameter of the column, nor greater than three inches; that the spiral be secured to the verticals at every intersection in such a manner as to insure the maintaining of its form and position, that the verticals be spaced so that their distance apart, measured on the circumference, be no greater than nine inches, nor one-eighth the circumference of the column within the hooping. In such columns, the action of the hooping may be assumed to increase the resistance of the concrete equivalent to two and one-half times the amount of the spiral hooping figured as vertical reinforcement. No part of the concrete outside of the hooping shall be considered as a part of the effective column section.

553. Structural Steel Columns.) When the vertical reinforcement consists of a structural steel column of box shape, with lattice or battenplates of such a form as to permit its being filled with and encased in concrete, the concrete may be stressed to one-fourth of its ultimate strength as given in table in Section 546, provided that no shape of less than one square inch section be used and that the spacing of the lacing or battens be not greater than the least width of the columns.

554. Curtain Walls in Skeleton Construction Buildings.) Buildings having a complete skeleton construction of steel or of reinforced concrete construction, or a combination of both, may have exterior walls of reinforced concrete eight inches thick; provided, however, that such walls shall support only their own weight and that such walls shall have steel reinforcement of not less than three-tenths of one per cent in each direction, vertically and horizontally, the rods spaced not more than twelve-inch centers and wired to each other at each intersection. All bars shall be lapped for a length sufficient to develop their full stress for the allowable unit stress for adhesion. Additional bars shall be set around openings, the verticals wired to the nearest horizontal bars, and the horizontal bars at top and bottom of openings shall be wired to the nearest vertical bars. The steel rods shall be combined with the concrete and placed where the combination will develop the greatest strength, and the rods shall be staggered or placed and secured so as to resist a pressure of thirty pounds per square foot, either from the exterior or from the interior on each and every square foot of each wall panel.

555. Bending and Elongation of Steel.) The bending and elongation of steel used in reinforced concrete construction shall conform to the following requirements:

(a) Steel having a diameter of three-fourths of an inch or less shall be capable of bending cold ninety degrees over a diameter equal to twice the thickness of the piece without fracture; steel over three-fourths inch in

diameter shall be capable of bending cold to ninety degrees over a diameter equal to three times the diameter of the piece.

(b) The material of reinforcement shall be such form that it will not elongate under working stress to exceed one fifteen-hundredth.

(c) Reinforcing steel used in reinforcing concrete construction shall not be painted, but shall be free from all mill scale and loose rust.

556. **Cement Tests.**) (a) Only Portland cement shall be used in reinforced concrete construction. All cement shall be tested in car load lots when delivered, or in quantities equal to the same. Cement failing to meet the requirements of accelerated test shall be rejected.

(b) Pats of neat cement must be allowed to harden twenty-four hours in moist air, and then be submitted to the accelerated test as follows: A pat is exposed in any convenient way in an atmosphere of steam, and above boiling water, in a loosely closed vessel for three hours, after which before the pat cools, it is placed in the boiling water for five additional hours. To pass this test satisfactorily, the pat shall remain firm and hard, and show no signs of cracking, distortion or disintegration.

(c) Portland cement when tested shall have a minimum tensile strength as follows: Neat cement after one day in moist air shall develop a tensile strength of at least 200 pounds per square inch; after one day in air and six days in water shall develop a tensile strength of at least 500 pounds per square inch, and after one day in air and twenty-seven days in water, shall develop a tensile strength of at least 600 pounds per square inch. Cement and sand tests composed of one part of cement and three parts of sand shall, after one day in air and six days in water, develop a tensile strength of at least 175 pounds per square inch; and after one day in air and twenty-seven days in water, shall develop a tensile strength of at least 240 pounds per square inch.

(d) A certificate that the cement used has been tested and has met the requirements of this section and that the tests have been made in accordance with the standard methods prescribed by the American Society for Testing Materials, on pages 149 to 164, both inclusive, of the proceedings of the Eleventh Annual Meeting of the American Society for Testing Materials, adopted August 15, 1908, shall be furnished by the architect or engineer in charge to the Commissioner of Buildings.

557. **Sand.**)... The sand to be used for concrete shall be clean, hard, coarse sand, of the grade known as torpedo sand, and free from loam or dirt, not less than 45 per centum shall be returned on a screen of 400 mesh to the square inch.

558. **Stone.**) The stone to be used in concrete shall be clean crushed hard stone or clean crushed blast furnace slag or gravel of a size to pass through a one-inch square mesh. If limestone or slag is used, it shall be screened to remove all dust; if gravel is used, it shall be thoroughly washed. Stone shall be drenched immediately before using. If slag is used, it shall be of such character that when made into concrete the concrete will develop a crushing strength equal to that specified for stone or gravel concrete.

559. **Mixing.** All concrete shall be mixed in a mechanical batch mixer except when limited quantities are required, or when the conditions of the work make hand mixing preferable; hand mixing to be done only when approved by the Commissioner of Buildings. In all mixing, the separate ingredients shall be measured for each batch and shall be thoroughly mixed and must be uniform in color, appearance and consistency before placing.

560. **Placing Concrete.**) In filling in concrete around

reinforcing steel, the concrete must be worked continuously with suitable tools, as it is put in place. Filling the forms completely and puddling afterward will not be permitted. In placing the concrete, the work shall be so laid out that partly set concrete will not be subjected to shocks from men wheeling or handling material over it.

561. **Concrete Placed in Freezing Weather.**) When concreting is carried on in freezing weather, the material must be heated, and such provisions made that the concrete can be put in place without freezing. The use of frozen lumpy sand, or stone depending on hot water used in mixing to thaw it out will not be permitted. All reinforced concrete shall be kept at a temperature above freezing for at least forty-eight hours after being put in place. All forms under concrete placed in freezing weather shall remain until all evidences of frost are absent from the concrete and the natural hardening of the concrete has proceeded to the point of safety.

562. **Concrete Placed in Warm Weather.** Concrete laid in warm weather shall be drenched with water twice daily, Sunday included, during the first week after being put in place.

563. **Cement Finish.**) Cement finish added to the top of slabs, beams, or girders shall not be calculated in the strength of a member unless laid integrally with the rough concrete. No greater unit stress shall be allowed on such cement finish than on the rough concrete.

564. **Fireproof Concrete Construction.**) Reinforced concrete construction will be accepted for fireproof buildings if designed as prescribed in this paragraph. The aggregate for such concrete shall be clean, broken stone or clean crushed blast furnace slag, or clean screened gravel, together with clean, coarse sand of the grade known as torpedo sand; stone, slag or gravel shall be of a size to pass through a screen of three-quarter inch square mesh. The minimum thickness of concrete surrounding the reinforcing members of reinforced concrete beams and girders shall be two inches on the bottom, and one and one-half inches on the sides of said beams and girders. The minimum thickness of concrete under slab rods shall be one inch; and all reinforcement in columns shall have a minimum protection of two inches of concrete except as hereinafter provided, if a supplementary metal fabric is placed in the concrete surrounding the reinforcing, simply for holding the concrete, the thickness of concrete under the reinforcing may be reduced by one-half inch, then such fabric shall not be considered as reinforcing metal.

565. **Removal of Form.**) In no case shall the props and shores used in reinforced concrete construction be removed from under floors and roofs in less than two weeks, except as is provided herein. Column forms shall not be removed in less than four days. The centering from bottom of slabs and sides of beams and girders may be removed after the concrete has set for one week, if the floor has obtained sufficient hardness to sustain the dead weight of said floor. No load or weight shall be placed on any portion of the construction until the concrete has fully set and the centers have been removed.

5566. **Tests.**) ...The contractor for the reinforced concrete construction shall make load tests on any portion of the work within a reasonable time after erection, as may be required by the Commissioner of Buildings. Such tests must be made under the direction of the Commissioner of Buildings in his presence or in the presence of his representative, and must show that the construction will sustain a load twice the sum of the live and dead loads for which it was designed, without any sign of failure. The construction may be considered as part of the test load. Each test load shall cover two or more panels and shall remain in place at least twenty-four hours. The

deflection under the full test load at the expiration of twenty-four hours shall not exceed one-eight-hundredth of the span. These tests shall be considered as tests of workmanship only.

THE EQUIPMENT OF THE CEMENT MILL OF THE PORTLAND CEMENT COMPANY OF UTAH.

The equipment of the Portland Cement Company of Utah, both at quarry and mill, has recently been thoroughly remodeled so that the operations thereat are of

quality. As is well known, the chief ingredients of good cement are silica, iron, alumina and lime in certain proportions, to obtain which it is necessary to mix two or more different kinds of rock. In this case the desired result is obtained by mixing an almost pure limestone with a calcareous shale, both of which are found in the Parley's Canyon quarry, occurring in alternate beds.

The remodeling and re-equipping referred to called for the expenditure of a considerable sum, so before it was finally decided upon a large portion of the ground in the canyon was prospected to determine the value

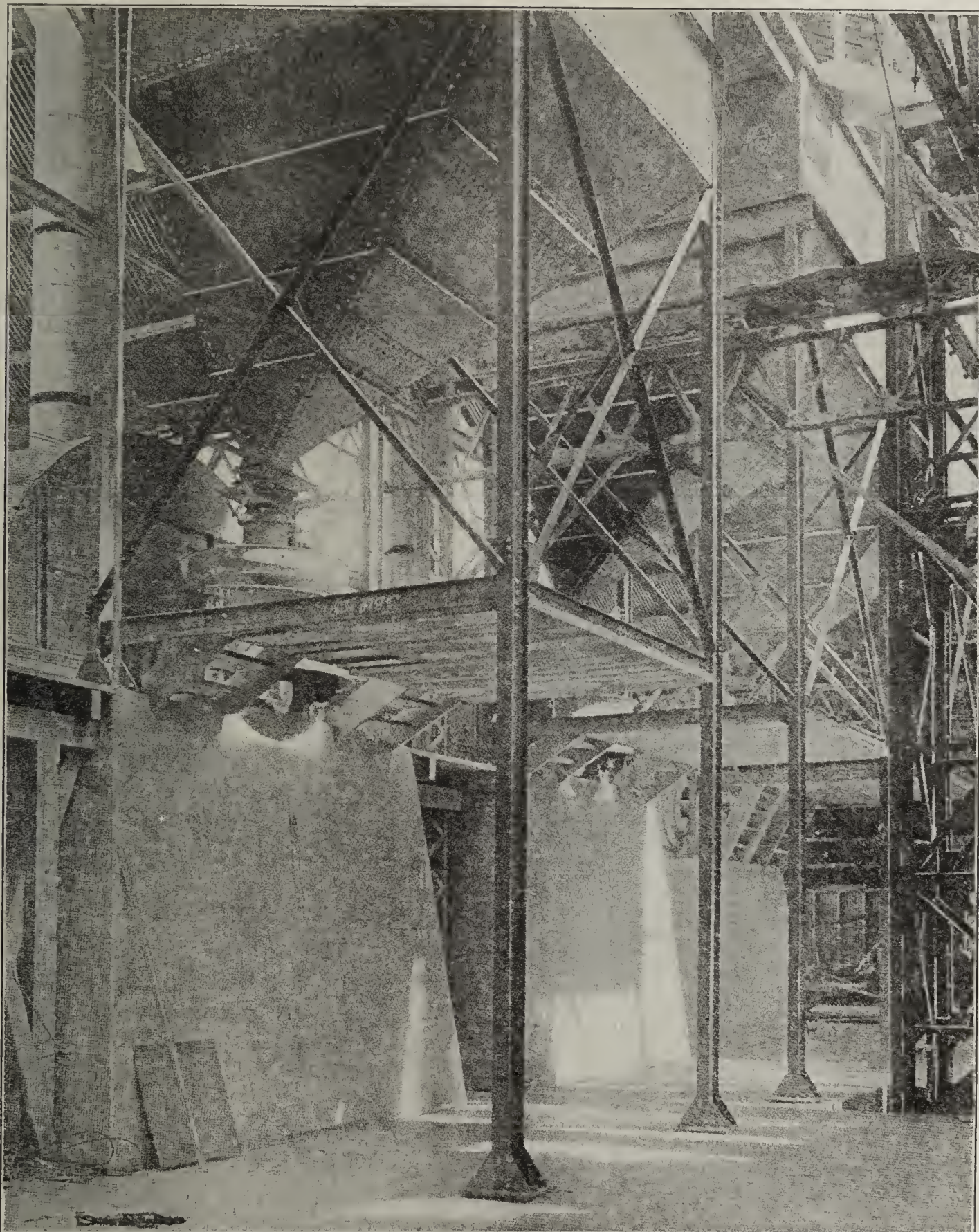


FIG. 1. VIEW OF THE RAW GRINDING KOMINUTERS, PORTLAND CEMENT CO. OF UTAH.

some interest as presenting an example of the most advanced type of cement manufacture.

The quarry is situated in Parley's Canyon, close by the Park City branch of the Denver & Rio Grande R. R., and nine miles from the plant in Salt Lake City. The ground owned by the company extends for nine miles along the canyon with a maximum width of $3\frac{1}{2}$ miles, containing a combination of rock such as is suitable for the manufacture of Portland cement of high

of the deposit. This prospecting was carried on by means of shafts which were made 3x3 ft., only sufficient size for one man to work, and carried to a depth of 25 to 80 ft., as the case required, by hand. Their object, primarily, was to determine the extent and thickness of the different beds, but they were so placed that when active quarrying operations were commenced they were used for blasting, although it was necessary to sink other shafts in between to make the blasts fully effective.

With the installation of the machinery at the quarry air hammer drills are used for sinking. The shafts are so placed as to give a burden of 30 to 40 ft. from the face for blasting. When down to the desired depth they are chambered at the bottom, loaded with Trojan powder and fired by means of a battery. The Trojan powder has been found to give good satisfaction in this work, combining some of the features of dynamite and black powder, and one shot is on record where 900 lbs. of powder moved 30,000 tons of rock.

The entire contract for conveying machinery was placed with the Stephens-Adamson Mfg. Co., Aurora, Ill., and included fourteen malleable bucket elevators averaging 40 foot centers, with steel heads and casings, three belt conveyors, and about 700 feet of extra heavy screw conveyor with casings.

In addition to this they furnished a 24"x18" pivoted bucket conveyor to take the hot material from the kilns, and an 18" Style No. 78 cast iron pan conveyor to take material from the dryers and distribute it to the bins; also a coal storage equipment.

In the old plant there were probably twelve different diameters of shaft, almost every known kind of chain and about six sizes of buckets for the elevators. In the new plant the policy of standardization has been carried out to an extent never before attempted in a cement plant of this size.

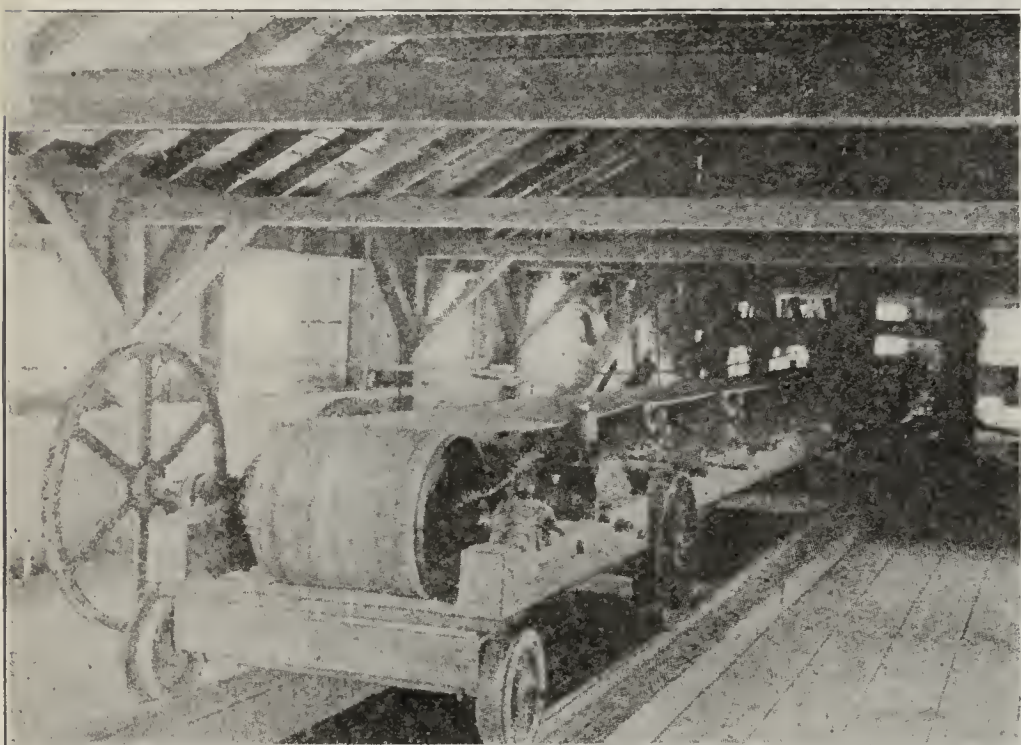


FIG. 2. BELT CONVEYOR AT QUARRY BIN, ARRANGED TO DUMP IN DIFFERENT BINS.

The broken rock is loaded to small push cars and trammed to the crusher house, which is not over 50 feet from the present working face. Here the car runs onto a cradle which automatically dumps it to the crushing floor in which is a No. 7½ Gates gyratory crusher set to crush to 2 ins., discharging to a pan elevator which raises the product to the bins. With each revolution of the elevator belt a butterfly gate is thrown open and the contents of one pan thrown out as a sample. This sample is passed through a laboratory crusher, cut down to about 5 lbs., labeled and sent to the laboratory at the mill for analysis. The elevator discharges to a horizontal belt-conveyor, which is rather unique in its action. The conveyor is one-half the length of the bin and is mounted on wheels which run on a track of T-rails. A rope drive imparts motion to the belt and a double solid jaw clutch permits of its direction being reversed. Another clutch throws in the connection between the belt pulley and the wheels so that it can be moved back and forth along the rails, thus bringing one end or the other over any one of the eight bins. This point is

quite essential as the different lots are kept carefully segregated from the time they are quarried until the treatment at the mill. The bins have flat bottom with a sliding center discharge gate to the railway cars which are run beneath on a siding.

Power for the crushing and hoisting machinery is furnished by a 100-HP. return tubular boiler and a 16x20-in. slide-valve engine. Air for the drills is furnished by an 8x8x10-in. straight line compressor.

The rock sample is analyzed at the mill laboratory, and the chemist advises the mine foreman which of the eight bins to ship. The rock is delivered in specially built side dump steel cars to the mill bin, which is a hopper shaped of steel, and fed from it to an inclined conveyor which dumps to a steel housed elevator. A commendable practice which is followed throughout the plant is employed at the elevator. This elevator is of the chain and sprocket type with the bottom pulley connected by chain and sprocket to the driving pulley of the feed belt, the latter receiving its motion from the elevator. Thus in case of accident to the elevator the feed is automatically cut off and there is no filling up of the boot with feed as is often the case.

The elevator discharges to a set of 40x15-in. rolls of the Anaconda type set to crush to 1 in. and discharging to another elevator which dumps the rock to the drier. The drier is a large revolving tube, resembling a tube mill or kiln, making a revolution in 14 secs. A coal fire is maintained in a brick firebox at one end and the flames strike down against the crushed rock and drive off all moisture, which is quite essential to the process. The drier has sufficient pitch that the feed works out of the lower end from which it goes to an elevator and is raised to the pan conveyor. This consists of an endless series of pans, each mounted on four wheels running on a track over the mill storage bins. Over each bin is a short stretch of track curving sharply downward beneath the straight track. At this point the straight rails can be swung outward so that the pan will follow the curved track downward and dump its contents into the bin beneath. In this way the dried rock can be dumped to any bin that may be desired.

Each storage bin terminates in a steel hopper in which is a lever-operated gate and, beneath, a swinging gate operated by an eccentric. By means of these two gates the feed from each bin may be regulated as closely as may be desired. These hoppers feed to a rubber belt conveyor and here occurs one of the most important steps in the process.

An analysis of the limestone or No. 1 rock shows:

Calcium carbonate	80.7%
Silica	10.3
Aluminum and iron oxides.....	6.2
Magnesium carbonate	2.5
	99.7%

Shale No. 2 rock:

Calcium carbonate	52.0%
Silica	28.5
Aluminum and iron oxides.....	14.5
Magnesium carbonate	4.5
	99.5%

These rocks, the composition of which will, of course, vary more or less from the above analyses, must be mixed in such proportions as to present a mix of the following composition:

Calcium carbonate	62.5%
Silica	22.0
Aluminum and iron oxides.....	10.5
Magnesium carbonate	2.3
	97.3%

It will be seen that the proportion of magnesium carbonate given in the last analyses could not be formed from the two lots taken as an example, but this is not essential as the magnesium and the lime have the same reactions in the kiln and the one will replace the other.

As stated, the different kinds of rock and the contents of the several bins are kept separate so that the chemist knows the exact composition of the rock in each of the storage bins in the mill. From this he figures his mixture and gives his instructions. The feeder to one bin that is to be used is started and the amount caught on one complete revolution of the conveyor belt is carefully weighed. The process is repeated with another bin and the feeders adjusted until exactly the correct proportion is obtained, when both feeders are started and the contents of both bins mixed on the belt.

The belt beneath the storage bins discharges to an inclined conveyor to an elevator which raises the rock, now mixed in the proper proportions, to a belt conveyor, which carries a tripper by which it is discharged to any one of the kominuter bins. There are two Lindhard kominuters and one Allis Chalmers ball mill. A pipe carries the feed from the bin to a revolving table which discharges it to the kominuter. The kominuter is like a ball mill with two annular screens of different mesh. The oversize of both screens is returned to the mill and the undersize discharges to a hopper beneath. This undersize will all pass a 20-mesh screen and 35% will pass a 100 mesh. The kominuters have a speed of 22 r. p. m.

The hopper discharges to a screw conveyor beneath the floor which carries the feed to an elevator, the scheme of having the elevator drive the feeder being followed. The elevator raises the now finely ground rock to the tube mill bins from which it is fed to three tube mills, two 6x22 ft. and one 5x22 ft., making 26 r. p. m. These roughing tubes, as they are called, pulverize the rock so that 95% will pass a 100-mesh screen and discharge it to a screw conveyor to an elevator, which dumps it to the bins above the kilns, of which there are two.

Each kiln is a steel tube with firebrick lining 8x125 ft. It is geared to a motor so as to make one revolution in 1 min. 40sec. The kiln has a slight pitch toward the firebox in which a fire is maintained by means of fine coal dust injected by a blower. The powdered rock is readily acted on by the heat, which is kept at 2,500° to 2,700° F. The charge requires from two to three hours to work through the entire length of the kiln, during which time the CO_2 in the carbonates is driven off and the calcium and magnesium unite with the other elements to form silicates, ferrates and aluminates of the following composition: 2 CaO SiO_2 , $x \text{ CaO Fe}_2\text{O}_3$, $2 \text{ CaO Al}_2\text{O}_3$. The proportion of lime in the ferrate varies so a definite formula for it cannot be given. The magnesium acts in the same manner as the lime.

The rock sinters into lumps in the kiln and is discharged through a hole, in the lower end to a bucket conveyor which elevates it to a rotary cooler. The cooler is a tube 6x60ft., similar in external appearance to a kiln but open at the lower end, the upper terminating in a stack. The feed enters the higher end and the rotary movement works it toward the lower, during which process the rock is cooled by the heat drawing cold air from the outside through the cooler.

The cooler discharges to the weigh tank in which the weight is carefully taken and the rock discharged to a receiving tank where 2% of raw gypsum is added to retard the set which would otherwise take place too quickly.

From the receiving tank the rock goes to an eleva-

tor which raises it to two kominuters making 24 r. p. m., which reduce it to 28 mesh, 38% to pass a 100-mesh screen, thence it is carried by a screw conveyor to an elevator which dumps to the tube mill bins. The finishing tubes are two in number, 6x22 ft., making 28 r. p. m., and grinding so that 95% will pass a 100-mesh screen. The discharge passes over a fine screen which takes out any chips of pebbles which may have been broken off in the mill. The now finished product is carried by a screw conveyor to an elevator which raises it to the stock bins.

The preparation of the coal for the kilns is a process of considerable importance, as it must be reduced to a fineness that will allow of complete combustion immediately on being blown into the firebox. It is unloaded from the cars by a swinging conveyor to a stockpile from which it is fed to a hopper to an elevator and passed through a rotary drier 5x10 ft. Thence it goes to a set of 24x18-in. disintegrating rolls, thence by elevator to a set of 30x14-in. crushing rolls and from them to a 5x20-ft. tube mill in which it is ground so that 95% will pass a 100-mesh screen. The dust is elevated to a bin and blown into the kiln by a 30-in. blower with a capacity of 4,000 cu. ft. of air per min., working at a pressure of 1 in. of water.

The plant has a well-equipped laboratory in which the analyses and tests are made. Analyses are made of each lot from the quarry and of the mixed rock. The raw product is sampled hourly and tested for fineness, and hourly samples are taken of the finished product and tested for initial and final set, fineness, soundness and tensile strength.

The plant is working 24 hours and putting out 1,400 bbls. per day.

A MODERN TYPE OF DOCK CONSTRUCTION.

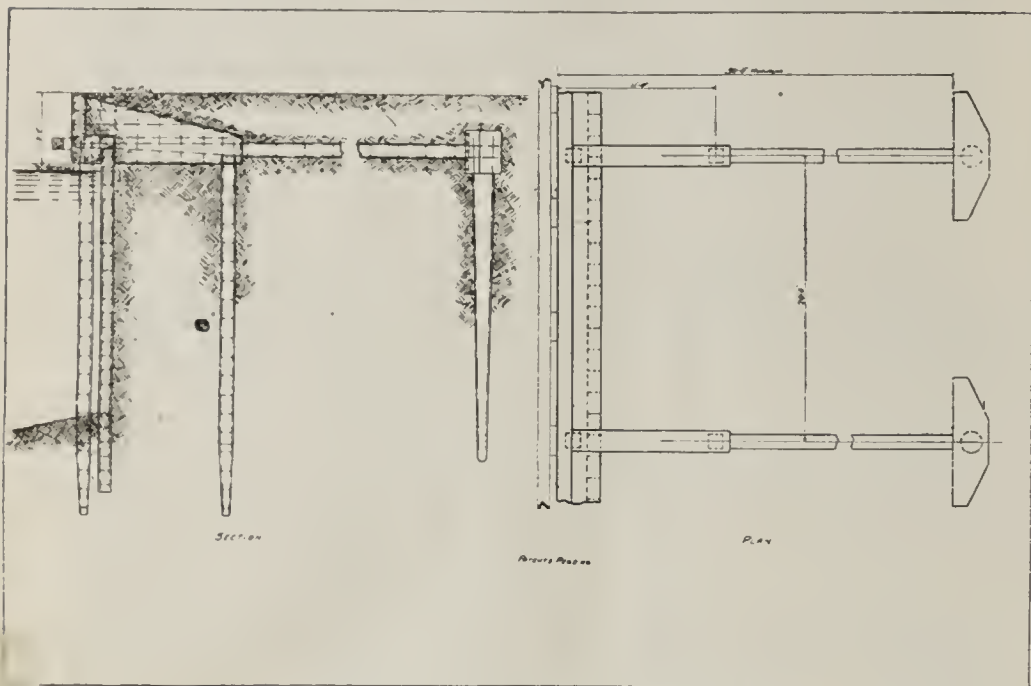
Harrison L. Garner.

At the Deering Works of the International Harvester Company, on the Chicago river, there is being completed a type of reinforced concrete dock which is destined to entirely supplant the old method of timber sheet pile construction. The Harvester Company, with its miles of docks along the Chicago river, was one of the first corporations to recognize the advantages of a concrete steel bulkhead in replacing the timber dock, which had decayed to such an extent that a portion of the switching tracks lying close to the river had been abandoned as unsafe for further use. Accordingly in June, 1909, the contract for placing 1,000 feet of bulkhead wall was awarded to the Raymond Concrete Pile Company. This piece of construction when finished gave evidence of such good service that an additional section of 1,550 feet was let to the same company, so that now a reinforced concrete wall supported by concrete piles extends along almost the entire east shore of the river between Fullerton avenue and Diversey boulevard.

The plan, cross-section and details of the dock as constructed are shown in the accompanying drawing. Test borings made along the bank of the river revealed rock overlain by a layer of hard-pan at a depth varying from 22 to 25 feet. To meet this condition reinforced concrete sheet piles 11x18 inches in cross-section and 24 feet in length were driven to form a continuous wall along the river and prevent the fill back of the dock line from crowding out into the water. The tops of these piles were left protruding about a foot above water.

Upon the heads of the sheet piles and bonded to them

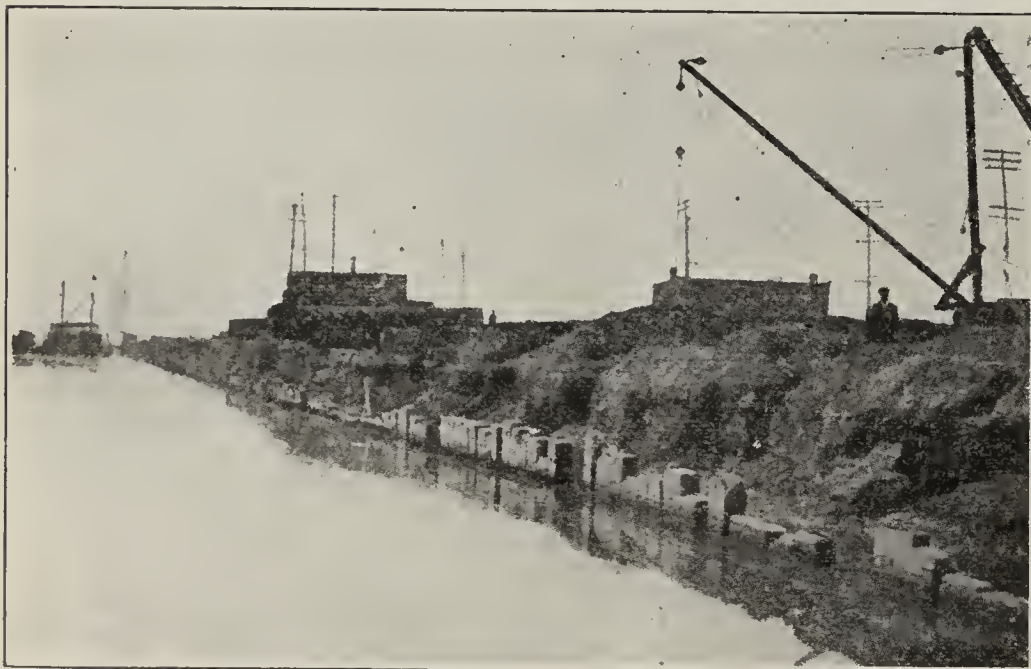
is built a concrete bulkhead beam reinforced both vertically and horizontally as shown in the drawing. This bulkhead has an L-shaped cross-section 3 feet in width and 5 feet in height. The bottom of the wall is 6 inches above the normal water level and its face projects 2 feet



Construction Details of Bulkhead.

beyond the outer face of the sheet piles. The center of gravity of the bulkhead is thrown entirely outside of the row of sheet piles as was intended by the design peculiar to the local conditions encountered. At 20-foot intervals are built transverse buttress walls resting on square reinforced concrete piles at either end. The bulkhead wall thus acts as a continuous beam and the load on the pile footings is comparatively small.

The bearing piles for the bulkhead wall, spaced 20 feet on centers, are 12 inches square and 24 feet in length. Spaced to correspond with these supporting



Reinforced Concrete Sheet Piling in Place.

piles are the transverse buttresses, 18 inches in thickness and extending 12 feet back from the face of the bulkhead. Under the rear ends of these buttresses are driven a row of square cast concrete piles similar to those supporting the bulkhead beam. The two rows of piles are driven 10 feet apart center to center.

The anchorage of the dock is designed to maintain its alignment under the most adverse conditions. A reinforced concrete tie beam connects the buttress with an anchor block, or "deadman" centered 35 feet from the dock line. Four $\frac{7}{8}$ inch square steel rods anchored in the "deadman" pass through the tie, through the buttress and turn a right angle within 3 inches of the face of the bulkhead beam. The concrete tie is 12 inches in cross-section and the longitudinal reinforcing rods

form a square 10 inches on a side, so that there is an inch of concrete on every side of the reinforcement. The rods are held in position laterally by $\frac{1}{4}$ inch steel hoops spaced 18 inches apart.

The anchor blocks are of reinforced concrete 3 feet deep, 2 feet 6 inches wide and with a bearing face 9 feet long parallel to the dock, thus giving a strong anchorage in the fill. To prevent any settlement of these "deadmen" each is supported on a standard Raymond foundation pile, the vertical reinforcement of which extends up into the anchor block. With this construction the whole dock, sheet piles, superstructure and anchorage, is bonded together until it is practically immovable.

The switching tracks of the International Harvester Company lie close to the river at the area where the piles were cast. A Chicago concrete mixer, run by a vertical boiler and engine, was set up in a clear space between the tracks. Sand and gravel were unloaded on material piles close to the mixer. Cement and the



Swinging Pile into Position for Driving.

steel reinforcement were housed in sheds to protect them from the weather. A couple of large areas close to the river were leveled off and on this was laid a 1-inch foundation consisting of 1 part cement to about 8 parts sand. These surfaces were covered with building paper and the wooden pile forms for the sheet piles built in place. The sides of the forms were made of 2x12-inch pine plank 24 feet long. The individual forms lay parallel in a row about 6 inches apart. The ends of the forms were made with two continuous planks.

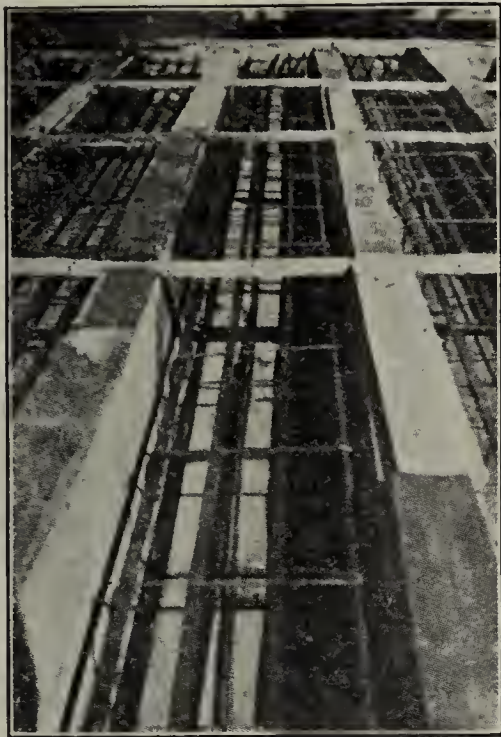
The sheet pile reinforcement was "made up" on a low scaffold and consisted of eight square steel bars 23 feet 6 inches long held in place by $\frac{1}{4}$ inch round steel hoops spaced 12 inches on centers.

The reinforcement was suspended in the wooden form from slats nailed across the top. The centering of the steel provided for a 1-inch thickness of concrete around the reinforcement laterally and a depth of 3 inches at the ends. A tin tube $1\frac{1}{2}$ inches in diameter and 12 inches in length was set upright in the form near the head of the pile. This opening through the concrete provided for the admission of a steel bar upon which a special device was hooked in handling the pile.

The concrete was mixed in the proportions of one part Chicago Portland cement, two parts torpedo sand, and four parts gravel. The mixture was wheeled up an inclined runway laid over the forms and dumped. Two laborers, one with a special concrete spade and the other

with a tamper, worked the concrete around the steel forms. A 1-inch board nailed at an angle in the form battered one side of the toe of the pile and shaped a wedge to assist in driving.

After one horizontal tier of piles had been cast a jack was put under each corner of the forms and the whole set raised up to make a second tier. Building paper was laid over the piles already cast, the forms straightened up, and work was then begun on a second tier. By this



Form and Reinforcement for Reinforced Concrete Sheet Piling.

method the piles were cast five tiers in height and the form, material and labor correspondingly greatly reduced.

The method used in casting the 12-inch square supporting piles was similar to the above. All cast piles were allowed to cure from thirty to forty days before they were driven.

The sheet piles were placed from a floating driver outfit. A 30x104-foot scow was fitted with a pair of driving leads, a cross-compound pumping engine, a derrick, a hoist engine and two boilers. The larger horizontal boiler furnished steam for the pump, while the smaller vertical boiler and the hoist engine were used in connection with the derrick and driver.

When seasoned for driving, the piles were picked up from the tiers by a boom swung from the derrick and loaded on the scow. The barge was then towed to the section to be driven and made fast to the dock. The hoist engine on the scow was employed to pull up the old waling and timber sheet piling. Two horizontal

timbers 12 inches apart served as guides for the continuous row of concrete piles.

In the process of driving, a sheet pile was picked up by the boom, swung into the leads and lowered in position between the guide timbers. A 2½-inch hydraulic jet under a pressure of about 160 pounds per square inch was carried by an iron pipe down beneath the toe of the pile. A section of fire hose was connected in the line to make the jetting system flexible. A 3-ton drop hammer in the leads followed the pile with light blows. A driving cap 3 inches in thickness, made up of 1-inch boards nailed together, took up the shock of the blow from the head of the pile. These driving caps were soon broken up, but had the advantage of being cheaply and quickly constructed. When a pile was lowered between the guide timbers a sling was thrown around it. This sling connected with a turn-buckle fastened to a preceding pile and a roller set on the outer side of the pile to be driven. By drawing the pile firmly up against the one last driven, the piles were kept close together. The guide timbers and the wedge-shaped toe assisted in preserving an almost perfect alignment.

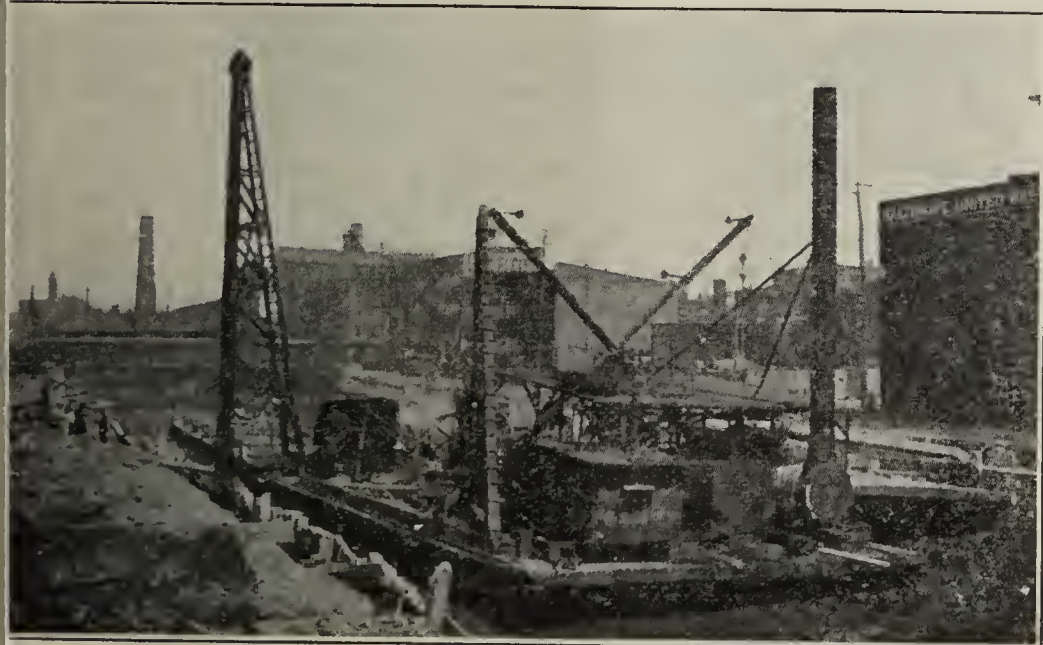
The square piles on the outside of the sheet pile wall which supported the bulkhead beam were driven from the scow. Those supporting the rear ends of the buttresses were put down with a land driver. This driver comprised a vertical boiler, engine, steam hammer, and a pair of leads, all supported by a pair of 12-inch oak rollers about 20 feet long. By means of the rollers the driver could be quickly moved in any direction from one pile to another.

The piles supporting the anchor blocks are of the standard Raymond "cast in place" type. A core or mandril 20 inches in diameter at the butt and 6 inches at the toe when expanded was suspended in the leads of the land driver. This core is divided longitudinally into two similar semi-conical steel parts, immovable vertically, but capable of being collapsed or expanded laterally by means of a system of wedges which can be turned about their points of attachment.

Number 20 gauge sheet steel in sections about four feet in length was bent into tapering cylindrical forms and riveted along the vertical edge on a cornice brake. The largest section of the cylindrical shell was slipped over the core and raised to the top of the leads. The smaller sections were then in turn placed in order upon the core, each overlapping by a few inches the previous one. A boot, stamped from a single piece of 16-gauge steel, was then slipped over the point. The core, encased in a steel shell, was lowered to the ground and driven to the required depth. The core was then collapsed and withdrawn, leaving the steel shell remaining in the ground. A 1:2:5 concrete mixture was poured into the shell and stamped. Two 1-inch steel bars were inserted in the shell and left protruding into the imposed "deadman" above. While one shell was being filled the driver was moved and began driving the next. In this manner the work rapidly progressed.

When the piles for a section of dock had been driven, the forms for the superstructure consisting of the bulkhead, buttresses, ties and anchor blocks were built. The reinforcing rods were placed and the concrete poured simultaneously. When the concrete had hardened, the forms were simply dismantled and moved to the next section. When a section was finished the space back of the bulkhead wall was back-filled and the switching-tracks, torn up during the construction, were relaid. A 10x10-inch oak walling, bolted to the face of the bulkhead beam, and separated from it at intervals by 8-inch blocks, completed the construction work on a section.

The dock was designed and constructed by the Raymond Concrete Pile Company, of Chicago and New

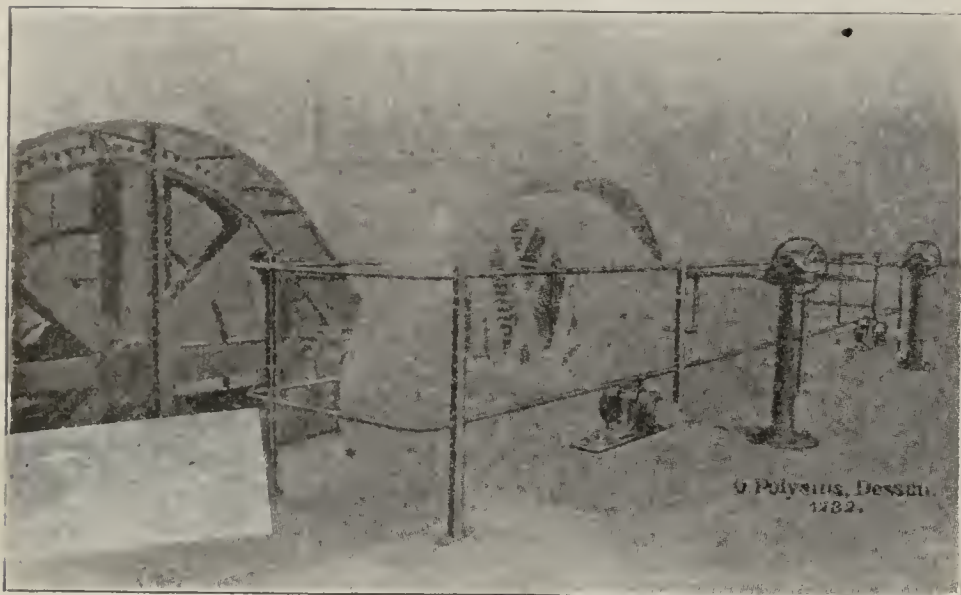


Floating Plant for Placing Piling.

York. Mr. George W. Seymour is general superintendent of the company; the late Mr. F. W. Webster, associate member A. S. C. E., was superintendent of construction on the Deering work, and the writer acted as assistant engineer.

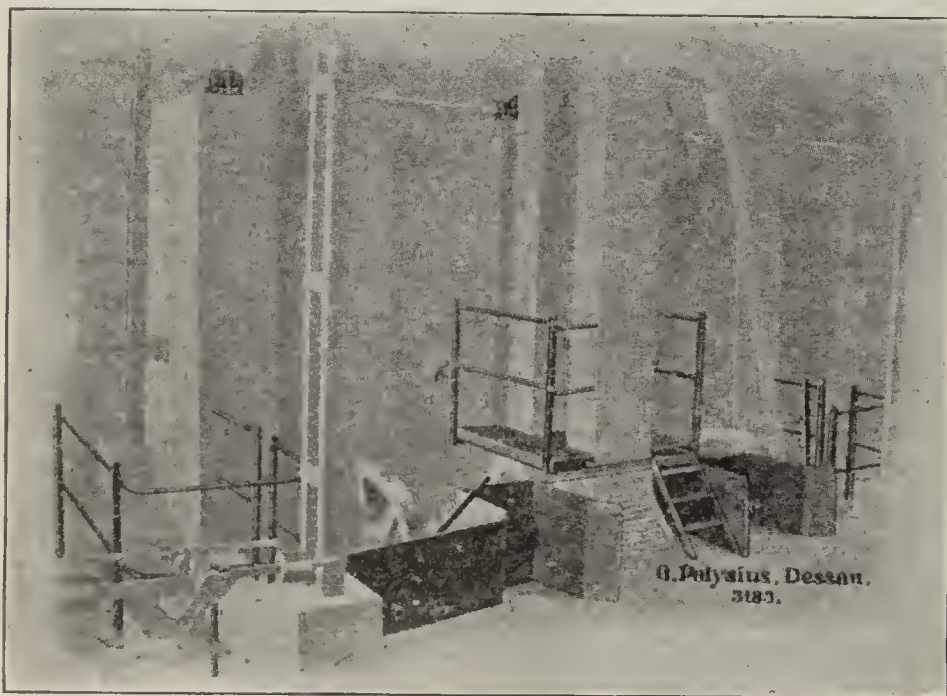
PROTECTION OF WORKMEN AT EUROPEAN CEMENT PLANTS.

A paper read before the German Portland Cement Manufacturers during their last February meeting in



Berlin brought out some interesting points with regard to the protection of life and limb at European cement plants.

That European workmen are better protected in every respect than American laborers is well known. Little has so far been done at American cement plants in the way of sanitary devices and protection from accidents. The atmosphere of grinding rooms and sacking and shipping departments is laden with cement dust so that it is mostly impossible to look from one end of the room to the other, whereas in Europe the sanitary police compels the owners of the plant to keep all of these departments scrupulously free of cement dust. This necessitates extensive installations of suction pipes and fans, which form a part of every European cement plant.



In guarding against accidents the European police is equally strict, as the accompanying illustrations show. Each machine or part of a machine, which is able to endanger the life of a human being, has to be carefully surrounded by railings, casings or housings of the pro-

per description and sufficiently strong to fulfill its duty.

Arguments on the subject between owners of cement plants and builders of machinery invariably brought out the fact, that the party furnishing the machinery was responsible for the proper protection of it, that all guards were considered parts of the machinery and that bids on machinery without including the necessary protection were unlawful. In the same way the owner of a cement plant is not allowed to award contracts for machinery without having all safety devices, guards, railings and housings included in the order.

This is, in our mind, a branch of the business in which the American cement manufacturer has to learn a great deal from his European colleague.

MID-WEST CEMENT EXPOSITION.

Nebraska and western Iowa are to give an exposition in Omaha, February 1, 2 and 3 of next year to be known as the Mid-West Cement Exposition. The show will be held in the Omaha auditorium. This building, built of cement and stone, has an exhibit space of 19,000 square feet and the Missouri river dealers and manufacturers propose to fill it with products of cement and cement handling machinery.

H. G. Calkins of the Nebraska Superior Portland Cement Company has been made chairman of the general arrangements committee for the exposition with F. W. Whipperman of the Omaha Concrete Stone Company as secretary.

While the Nebraska Cement Users' Association is responsible for the exposition, Pres. H. C. McCord has made a contract with the Omaha Commercial Club



to finance the exposition and it will be under the management of the local committee headed by Mr. Calkins.

The annual convention of the Nebraska Cement Users' Association will be held in Omaha during the exposition. The show will be widely advertised and it is expected to be an exposition which will be a big boost to cement products. The manufacturers will be in attendance to see the machinery exhibited while the general public will have an opportunity to see the possibilities of cement building materials.

With the large space offered in the Omaha auditorium it is possible to erect anything from a cement house to a cement silo built of blocks. Farmers of Nebraska are using cement to a greater extent than ever, there being half a dozen cement silos almost within the city limits of Omaha which have been recently erected by dairymen. The aim of the exposition will be to show farmers the advantages of cement construction. Manager Gillen of the Auditorium company, estimates that no less than 3,000 people will visit the exposition during the three days it will be open in Omaha.

THE DISINTEGRATION OF CEMENT FLOORS AND SIDEWALKS.

By Alfred H. White.

The superficial phenomena accompanying the disintegration of cement floors and sidewalks are common enough to obtrude themselves all too often upon the attention of even the casual observer. The uncertainty as to the causes of the unsatisfactory behavior and the doubt as to the tenure of usefulness of such cement surfaces must have caused other materials to be preferred to cement in very many cases. Yet the existence in good condition of cement sidewalks after more than a quarter of a century's service shows that the trouble is not necessarily inherent in the cement nor in the manner of using it. The following discussion of the causes of trouble and the means of avoiding it is based largely on experiments conducted by members of the department of Chemical Engineering at the University of Michigan. The subject is considered from the standpoint of the slow chemical changes which hydraulic cement undergoes during the setting and hardening process, which may result in visible ill-effects only after lapse of many years. The effect of the natural atmospheric agencies is also considered.

It is assumed in this discussion that the hydraulic cement is Portland cement, which has been mixed with water of acceptable quality, neither the influence of sea-water nor of the objectionable alkali waters of the western states being considered. It is also assumed that the sand and gravel used in concrete can be considered as entirely inert and stable mineral matter without decomposable organic material or objectionable mineral substances, such as sulphides, which are frequently present in cinders.

The measurements upon which this paper is based have all been made upon bars of neat cement. Conclusions drawn from them will apply only qualitatively to concrete consisting largely of inert sand and gravel. An expansion or contraction of the neat cement will indicate a movement of the concrete in the same direction, the extent of this movement being manifestly a function of at least two independent variables—the proportion of cement and the proportion of voids in the concrete. We have made no attempt to determine the influence of this latter factor, which varies widely in difference of manipulation, as has been shown by published results. Data summarized by Sab—show that on the whole the changes are more nearly proportionate to the percentage of cement used than would be expected. However, when any attempt has been made in this paper to make quantitative assumptions it has been expressly mentioned in the accompanying text.

This discussion of the deterioration of cement surfaces restricts itself to the usual causes which may be operative in the central portion of the United States, where the surfaces may be either continuously or intermittently wet or dry and may be subject to the action of frost. It may be considered under the following heads:

1. Normal changes of volume when good cement is properly used; disintegration of cement surfaces alternately wet and dry.
2. Effects of bad cement; free lime; free magnesia.
3. Effect of unfavorable conditions during hardening process.

Normal Changes in Volume When Good Cement is Properly Used.

Good cement when mixed neat with water will set hard in from one to ten hours. It would be ideal if there should be absolutely no change in volume after the cement has thus taken its hard set, but this ideal cannot be attained in practice. Exact measurements made on bars of neat cement which have stood in the air for six years show in all cases a gradual *contraction* which at the end

of a year amounts to between .2 and .3 per cent, and at the end of six years to another .1 per cent, the total contraction being about .4 per cent.

A similar bar of good cement placed in water will *expand* slowly and quite regularly, the expansion at the end of one year being about .1 per cent and increasing very slowly to five years, after which the volume remains almost constant with a total expansion of less than .2 per cent over its initial volume. Cement which has been aged before it is used will show sometimes less than half this expansion.

A bar of neat cement kept in water always shows expansion, and one kept in air contraction. This behavior is due entirely to the mechanical action of the water, for if a bar which has been kept in water be allowed to dry out it slowly contracts, and if after this treatment it be placed again in water it expands. This alternate contraction and expansion caused by wetting and drying of neat cement amounts to about .15 per cent. This is roughly 250 times as great as the expansion caused by a change of temperature of 1° F.

Disintegration of Concrete Surfaces Alternately Wet and Dry.

The surface coating of concrete walks and stuccoed outside walls is often as rich a mixture as 1:1 and is not usually poorer than 1:2 of sand. These figures indicate that even making allowance for the dilution by the sand that the change in volume of these rich mixtures, due to alternate wetting and drying, will be fully as great as that due to change from winter to summer temperature. These two factors of temperature and moisture may sometimes tend to neutralize one another and sometimes be cumulative. A stuccoed wall which is wet in summer may expand twice as much as would be expected from the temperature alone. Fortunately, the steel lath usually used is from its construction elastic and yields, but it is no wonder if hair cracks appear when the mortar is too rich.

This phenomenon is particularly important in cement walks where the base of lean concrete may be considered as being always moist in the summer. The surface is, however, alternately dry and wet, and is moreover much richer in cement, so that its contraction and expansion will be greater. If we assume that in summer the base of the sidewalk remains a constant volume and that the surface expands and contracts one-third as much as neat cement of 0.5 per cent between the dry and the wet state, we will have a change of volume of the surface, compared with the base, of over half an inch on a 100-foot walk. Expansion joints in walks are even more necessary on this account than to allow for temperature changes.

This unconsidered expansion and contraction was undoubtedly responsible for the disintegration of walks laid at a time when the practice was to put down a considerable section of the base and let it set before applying the top coat, with the result that the top coat was so poorly bonded to the lower part that it split off. The dishing of each section on older walks may be laid to this same cause. The surface contracting in dry weather would warp a light base or would split off from the base and itself become warped before it would be broken by traffic.

The modern practice of applying the surface coating before the base has set gives a firm bond that should be strong enough to prevent warping.

Effects of Bad Cement.

No cement should ever be used for any purpose which fails to pass the steaming test for constancy of volume as embodied in the standard specification of the American Society for Testing Materials. It is a mistake to assume that since cement coatings do not have to support any load inferior cement may be used in them. The

tensile strength and fineness of grinding may indeed be of minor importance, but changes in volume which might be negligible when the cement is mixed with seven parts of gravel lead to very evident defects in a rich cement coating.

The evils of unsound cements are due to their excessive expansion after setting. It is probable that the only two important agents which cause this undue expansion are free lime, which causes slow expansion both in water and air, and free magnesia, which causes very slow expansion in water, but does not cause expansion in air.

Effect of Free Lime.

Lime which has been burned at a low red heat and then finely ground, hydrates within a very few minutes after being brought in contact with water, and would not therefore be injurious as a constituent of Portland cement. Lime which has been burned at white heat of the Portland cement kiln hydrates much more slowly and expands fifty per cent more than the lime burned at the lower temperature.

The expansion due to free lime when the cement is kept under water occurs mostly during the first seven days and is apparently complete by the end of two months. The disintegration of cement surfaces which have been constantly wet can therefore not be laid to free lime unless trouble manifests itself within two months after the work is done.

The expansion due to free lime appears much more slowly when the cement is exposed to the air after hardening. It can hardly be detected after one month even when the cement is so bad as to utterly go to pieces on the boiling test. A bar of neat cement with much free lime still showed a decided contraction after one month in the air, although not quite so large as good cement should show under similar conditions. At the end of two months the contraction had changed to a positive expansion, which at the end of nine months had amounted to over one per cent. At the end of a year the bar was too badly cracked to allow further measurement. The expansion due to free lime does not always take place even this rapidly, however, for we have on record measurements on a bar made from cement showing bad cracks on the boiling test which did not expand enough to equal its initial measurement until after five years. Now, after eight years, its expansion is nearly fourtenths of one per cent over its initial volume. Very few engineers would contemplate with equanimity the prospect of such a change in volume in cement which was to go into structures for which they were responsible, but still they do not always take adequate precautions to exclude undesirable cements of this type.

Effects of Free Magnesia.

Magnesia is a more insidious foe than lime, for it is not always detected by the boiling test. The standard specifications for cement restrict the total magnesia to 4 per cent, which is probably safe. A larger amount is sometimes harmless, as has been shown in previous publications from this laboratory, but until a better method of detecting dangerous magnesia has been developed, the only safe way is to keep within known safe limits.

Magnesia, when burned hard, as in Portland cement, hydrates and expands very slowly in water, the expansion being hardly noticeable until a year has elapsed, and continuing for many years. Our series has been running for seven years and a recently published article by Dyckerhoff gives a similar series of measurements for eleven years. Both series agree in showing that the expansion has not yet ceased.

The effect of such slow and steady expansion may be seen on the State street side of the campus of the Uni-

versity of Michigan, where an unbroken walk, one-quarter of a mile long, was laid in 1896. The walk was cut into four-foot blocks, but apparently no special expansion joints were provided. The writer recalls that the first sign of depreciation he noted in the walk was the appearance of a few bumps, easily apparent to a bicyclist passing over them. An inspection of the walk at these points showed that the top coat had parted from the base and had been strong enough to resist the lateral thrust of expansion, so that instead of crumbling, the two slabs had been forced into an inverted V position, under which two fingers could be easily inserted. About once a year one of these humps would appear, be knocked out and replaced. The last one two years ago was examined by the writer, who found the upheaved slab about one inch thick, and so hard that it was not easy to break it with a hand hammer. At the present time, the walk is after twelve years' service, in rather bad condition. In the quarter-mile stretch there are also patches of replaced cement, which the writer attributes to these upheavals. In several other places slight upheavals are to be noted, and the top coating is broken in many places, and probably detached from its base almost everywhere. These results cannot be ascribed to thermal expansion, but can be due only to the steady expansion of the cement used. So far as is known, free magnesia is the only constituent of the cement that could account for it. It is impossible to prove it, because no chemical examination of the cement was ever made. Other instances of similar expansion might be cited.

So far as is known, magnesia exerts no harmful influence in the floors of buildings which are always dry. Apparently the hydration of magnesia under such circumstances is so slow that it cannot be detected even after five years. However, since it is possible to get cement with a safe amount of magnesia without any extra cost, very few people will care to experiment with high magnesia cements.

Dangers in Warm Weather.

The hardening process takes place only in presence of moisture and therefore the cement surface must be kept wet until it has progressed enough to give considerable strength to the concrete. The capillarity of the concrete usually retains sufficient moisture in the interior of the mass, but the surface must be protected from too rapid evaporation in warm weather. Cement walks sometimes show the effects of this in a crumbling surface not over a quarter of an inch in depth, the top coat below this being sound. Cement floors in reinforced concrete buildings may show an aggravated form of this same trouble where the top coating has been laid on a dry and porous concrete floor which sucks the water from the top coating, leaving it dry and friable.

Dangers in Cold Weather.

A low temperature delays the setting of Portland cement, as it does all other chemical reactions. So far as we know, however, it will be only the rate of reaction which will change with temperature, and the final products should be the same. A case has recently come to the writer's attention which indicates that there may be another source of trouble when the set of the cement is excessively slow. A cement coating is composed of particles of different specific gravity, the cement being heavier than the sand. The fine particles of sand work to the surface, or are carried there by the capillary action of the evaporating water, while the heavier cement tends to settle to the bottom, leaving the surface skin deficient in cement and consequently friable. It is apparently not advisable to lay cement floors where the initial set may be delayed so long that the surface cannot

be troweled within two hours after the cement is poured.

It is also dangerous to heat the room with open fires while the cement is setting, as, if the temperature is only a few degrees above freezing, the carbon dioxide from the fires will form an unstable modification of calcium carbonate, which will disintegrate when the temperature rises and makes a very friable surface.

The freezing of water in concrete introduces a different factor, on account of the expansion of the ice, which must inevitably have a disintegrating effect on the concrete. If the freezing takes place, as it sometimes does on the surface, soon after the concrete has been put in place, and afterwards the water thaws, the hardening process will continue. It is possible that the danger may thus partially repair itself, the situation being somewhat similar to that obtained when concrete is mechanically disturbed after it has started to harden. The new crystalline growth will not, however, be able to bridge any but microscopic crevices, and the material will almost certainly show unrepaired cracks, which will cause weakness and rapid disintegration if the surface is exposed to abrasion.

Summary.

The cracking and distintegration of concrete floors, walks and walls composed of mixtures rich in cement may be due to lack of knowledge of the properties inherent in all cement coatings, or to use of defective cement, or to improper use of good cement. All cement surfaces expand when wet and contract when dry, and in any large piece of work expansion joints must be allowed. Cement surfaces rich in cement and alternately wet and dry, as is the case with side walks, are especially liable to distintegration through the expansion and contraction of the top coat on the relative constant base. The top coat must be bonded very firmly to the base to prevent this.

The trouble due to defective cement is caused by the slow expansion of free lime or magnesia in the cement. The cement should always be tested before use, especially for sidewalks, where the cement is put under more trying conditions than in any other common use to which it may be put.

Trouble due to improper use of good cement, aside from use of too little cement and defective mixing, may usually be laid to too rapid drying of the cement in warm weather, or to too slow a set in cold weather. There is danger in the use of open fires to warm rooms where floors are being laid because of the action of carbon dioxide on the cement.

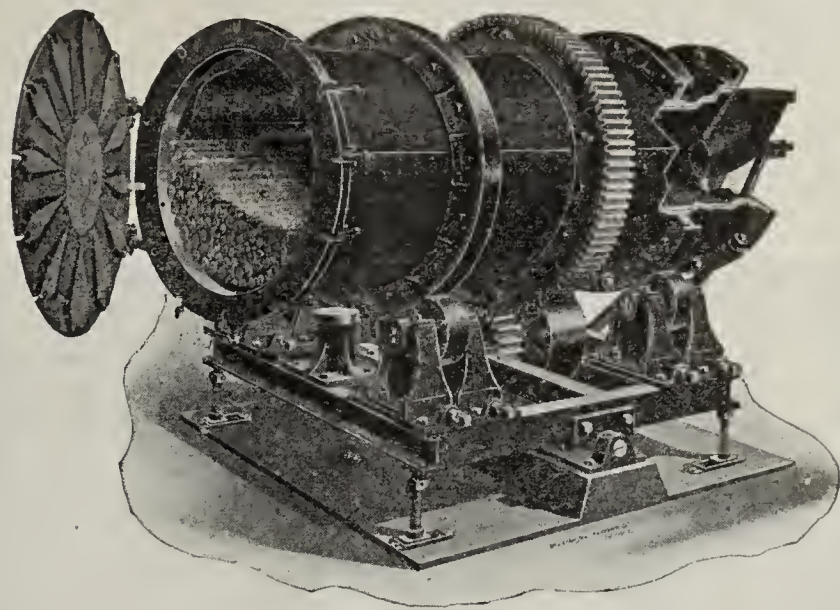
NEW FORT DODGE CEMENT MILL.

F.D. Brandenburg, president, Fort Dodge Portland Cement Corporation, First National Bank Building, Fort Dodge, Iowa, writes us that construction work is under way on the new cement plant at Gilmore City, Iowa. It will have a daily capacity of 5000 barrels "Fort Dodge" Portland cement. Ten 8x125 feet, kilns will be installed. Dry process. Coal for burning. The capitalization of the company is \$3,500,000. The Gilmore City Construction Company of Gilmore City, Iowa, are the contractors and Mr. C. McLaughlin, 215 Reliance Building, Kansas City, Mo. is the engineer. The company will also sell crushed rock for commercial purposes, the daily output of which will be about 1500 tons. The officers are F. D. Brandenburg, president; R. H. Van Alstine and M. J. Nicholson, vice-presidents; T. A. Mair, general manager; H. S. Van Alstine, secretary and treasurer.

THE MARATHON MILL.

The MARATHON MILL is the name of the latest type of grinding mill suitable for reducing to powder clay, limestone, cement clinker, coal or any kind of raw material used in the manufacture of cement as well as in many other industries.

The MARATHON GRINDER is a cylindrical drum with a specially designed lining of the hardest metal, nearly half filled with loose, round iron or steel rods, three to four inches in diameter and approximately as long as the drum. The mill is adjustable to take any size feed up to two inches, direct from a rock breaker, and, either wet or dry, with only one passage through the machine, produce a uniform product of any size from coarse down to 200 mesh or finer, and without the use of screens.



The Marathon Grinding Mill.

A great feature of this MARATHON MILL is the TILTING DEVICE. The machine is mounted on heavy transverse center bearings, enabling the mill to be inclined downward more or less, as desired, toward the end being used for discharge, thus producing a positive, rapid progression of the material through the drum, giving the machine a much greater capacity than the pebble mill which has to be run with the drum in a horizontal position. The MARATHON GRINDER being a multiple roll machine has several times the capacity of any single set of rolls, stamps or any other grinding mill. More or less tilting also regulates the output as to size, making the finished product more or less fine. The length of the mill also affects the fineness of the product. Other conditions being the same, a long drum produces a finer product than a short one. Therefore this MARATHON MILL is adaptable to any and all kinds of grinding with the greatest possible range of variation.

The MARATHON GRINDER is equally superior, either as a wet or dry pulverizer. Simply reversing the discharge head, which is smooth on the other side, making a water tight gasket joint with the drum flange, changes the mill from a dry to a wet grinder. In the latter case, the flanged plug shown in the picture as filling the central discharge hole to keep the dust in for dry grinding, is removed, and in its place is fastened a pipe flange with a short pipe screwed into it so as to discharge from the center; but in dry pulverizing the ground pulp drops down through the peripheral discharge channels shown in the head. When grinding dry it is better to have the whole discharge end enclosed by a hood with a bottom hopper and a suction draft to carry away the dust.

The Marathon Mill is manufactured by the Johnson Engineering Works, First National Bank Bldg., Chicago, Ill.

JEFFREY FLIGHT CONVEYOR AT NEW YORK CEMENT SHOW.

The cost of manufacture of Portland cement has been gradually decreased by replacing manual labor by machinery in all possible cases. With the exception of the shipping department, there is hardly a place at a modern cement plant at which the material is handled. Probably no device has contributed as much towards reducing expenses as the installation of conveying machinery.

Attention is hereby called to the several conveying systems that are being used for delivering the rock to the crushers. Figure 1 shows a Jeffrey Steel Drop Pan Conveyor which extends over the entire length of the crusher building on the longitudinal center line of the latter. This Conveyor line is 130 feet between centers, traveling at the rate of 70 feet per minute, geared to a single phase alternating current, continuous speed motor. Each pan section of the Conveyor is 18 inches wide, 24 inches long and 6 inches high, carried on two axles supported by two pairs of flanged wheels placed at the ends of every pan and traveling

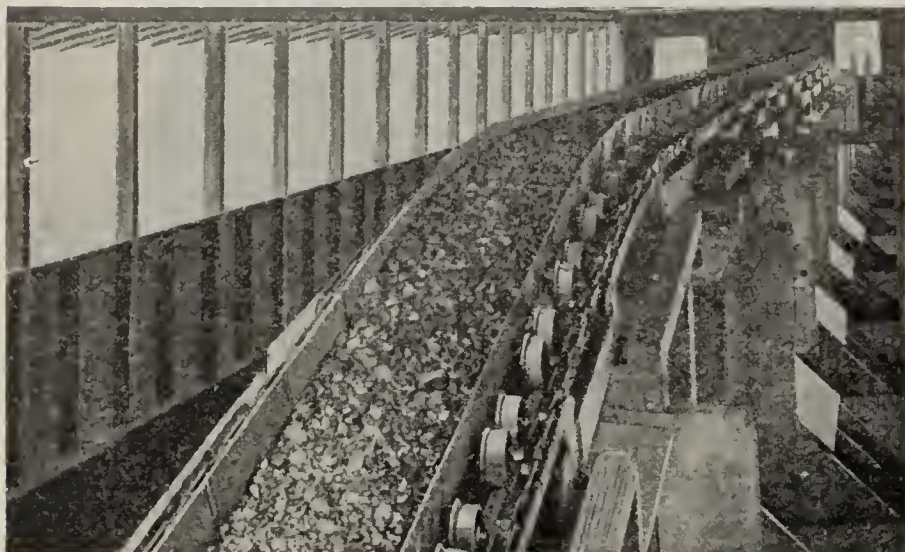


Fig. 1. Jeffrey Pan Conveyor delivering crushed stone overhead bunker.

on a pair of rails on a frame spanning the chutes to the crushers. Only one of the axles extends to the chain allowing the pan to pivot freely between two strands of chains. The rails are in sections hinged over each chute so that any section may swing out of the way.

This Conveyor system is so designed that when each pan reaches a delivery point where a section of the track has been taken out, the rear end of the pan automatically drops down and the load is discharged into the chute below; as the Conveyor proceeds, the pan returns. The separate piece of track swings back in no way interfering with the movement of the Conveyor.

There are other types of Conveyors used for handling material of this kind, including the Rubber Belt Conveyor, as well as pivoted Bucket Conveyors.

Where Rubber Belt Conveyors are used an automatic tripper is also used which enables the discharging of material on either side of the Conveyor line.

Figures 2 and 3 show a Jeffrey Flight Conveyor. This type of Conveyor is used for handling barrels, either filled or empty from various parts of the mill; either to or from warehouses as well as to the shipping floors. The construction of this Conveyor is very simple but amply strong to handle this material.

These photographs represent the method of handling a cargo of cement from the warehouse to the dock at Seattle, Wash. In this way over 3000 barrels were readily handled in 8 hours by a crew of 18 men. This included all the necessary labor for handling the barrels in the warehouse, chuting them to the lower floors

and delivering them to the dock where they were loaded by means of the ship's derrick to the hold of the vessel.

This Conveyor line is made up of transverse wooden flights attached to roller Conveyor chains. The flights

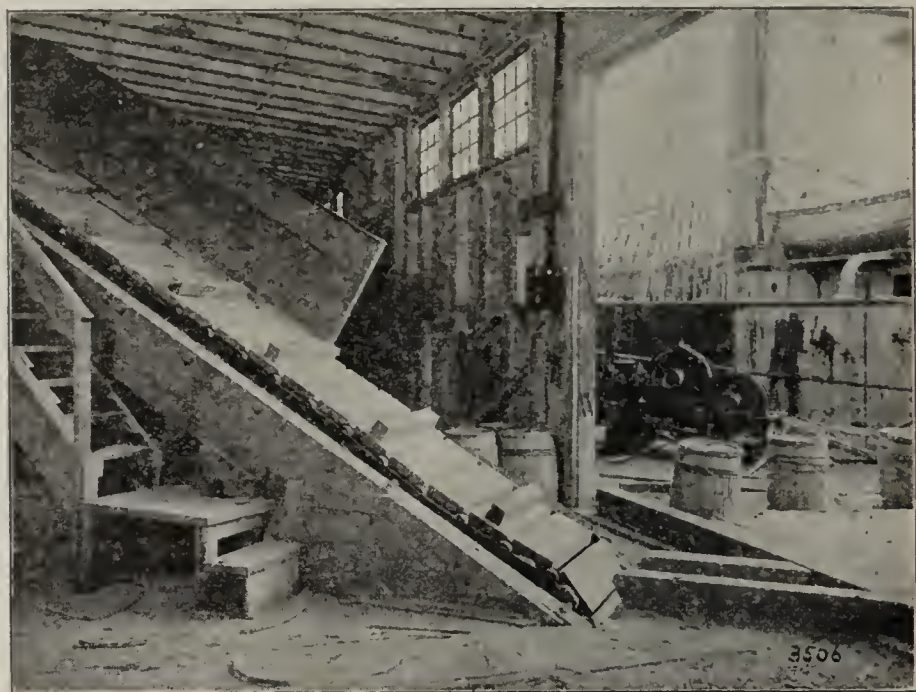


Fig. 2. Jeffrey Flight Conveyor for handling barrels of Cement.

are of Puget Sound fir and are each 3 feet long, 1 foot wide and 3 inches thick. As assembled, they form a practically continuous Apron 3 feet wide. Wooden cleats are bolted to the face of every third flight. The flights are attached at each end to the rolling chains. Each chain link consists of two flat steel bars about 13 inches long, separated by the width of the rollers, one of which is mounted on each link-joint pin. The rollers run on rails.

At each end of the Conveyor, the chains pass over sprocket wheels about 3 feet in diameter. The conveyor is continuous and the return side runs on separate rails a foot or so below the carrying side.

This conveyor line is designed to carry safely 150 pounds per running foot, or a single load of 2000 pounds concentrated at one point. The maximum capacity when handling cement in barrels is 1200 pounds per hour.

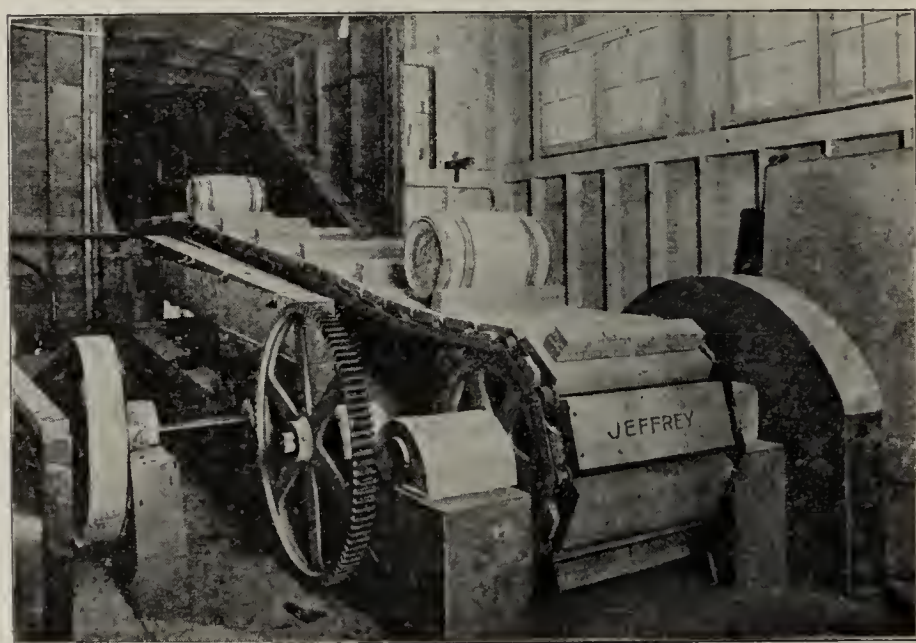


Fig. 3. Another view of Jeffrey Flight Conveyor delivering barrels of Cement.

Figure 3 shows the delivering end of the Conveyor line which reaches to the dock.

This system was designed and built by the Jeffrey Manufacturing Company, Columbus, Ohio. The Jeffrey people have made a specialty of handling materials in

and about Cement Mills including pulverizing and crushing machinery, also coal and ashes handling machinery for power plants.

A number of working models as well as enlarged photographs showing installations in various cement industries will be on exhibition at the Jeffrey Exhibit at the New York Cement Show.

NEW KANSAS CITY FREIGHT STATION.

Kansas City has been coming to the front for a number of years and long ago took her place among the leading cities of the country. It is one of the most important railroad centers in the Middle West, all of which is well attested by the railroad improvements which have taken place there.

Concrete and every other improved method of modern conception have entered into the building improvements in Kansas City, as they have in every other progressive city.

Recently the contract was let by the Chicago and Rock Island Railroad for a new freight station in Kansas City to take care of the constantly increasing freight traffic, inbound and outbound, which had to be handled. H. T. Hawk, architect for the Rock Island Lines, drafted the plans for the new station. Following other experiences in reinforced concrete building construction, he specified Ferro-Lithic Plates manufactured by the Berger Mfg. Company, of Canton, Ohio. This Ferro-Lithic Plate consists of dove-tailed cross-ribbed steel sheets which act both as form and reinforcement. The concrete is applied on the upper side, while a good plastering surface remains on the lower side.

A great saving in time is secured by this construction since no wooden forms are needed. It also saves the waste lumber inseparable from wooden forms.

This construction is to be used for the ceiling of the second floor of the new station, which will be used by the office force. The building is now under construction, the contractors being George B. Swift & Company of Chicago.

As the result of this step in concrete construction taken by the Rock Island Lines' chief architect, it is expected that hereafter similar buildings erected by the railroad along its route will include specifications for Ferro-Lithic. The Kansas City freight station is planned as a model in up-to-date railroad building construction and an object to the Middle West.

NEW PLANT FOR INTERNATIONAL LIME CO.

The International Lime company of Kendall, Wash., has ordered machinery for its new lime kilns and is now busy clearing a site for assembling machinery. The company is composed largely of Seattle capitalists. Jesse Frye, Alaska building, is president.

CEMENT MILL NEWS.

W. L. Warford has been appointed superintendent of the Superior Portland Cement plant at Concrete, Wash.

Last month was a record breaker in the production of high grade Portland cement at the plant of the Standard Portland Cement Company's works at Leeds, Ala. C. M. Goodman is now superintendent.

J. W. Williams of Hartwell, Ga. writes that he has a fine piece of cement and slate land (270 acres) near Rockmart, Ga., 75 miles above Atlanta and would be pleased to have capitalists develop it. The property has been pronounced by experts to contain a high grade material for the manufacture of cement.

KNICKERBOCKER CEMENT PLANT GOING UP.

Work on the construction of the new Knickerbocker cement plant being erected at Greenport, N. Y., near Fountain Head, is progressing very rapidly. The president and general manager, Sheldon H. Basset, states that the three mammoth buildings that will compose the plant will be ready for operation when spring comes.

Work on the foundation of the large main building has been finished, the walls of this foundation being nine inches thick and are reinforced with great piers projecting from the walls inwardly. In the center of the basement are also placed large piers to further strengthen the support of the building. Three tall smokestacks are being erected, each 200 feet in height. The plant is to be equipped with the very latest machinery and will be operated entirely by turbine power.

"The machinery is arriving rapidly," said Mr. Basset, "and is being installed as fast as the building goes up. The plant will be even larger than the plant of the New York and New England Cement & Lime Company at Hudson, N. Y."

The company has secured as its general traffic manager Thomas M. Magiff, one of the best posted authorities on cement construction in the country. The plant will employ 1,500 men when completed.

CANADIAN CEMENT SHOW.

Mr. R. E. W. Hagarty, secretary, 622 Euclid Avenue, Toronto, Canada, writes us as follows:—

"I wish to state that the Canadian Cement and Concrete Association are making extremely elaborate plans for a large convention and exhibition to be held in Toronto in all probability on January 16, 17, 18, 19 and 20th. We expect to have an unusually large number of delegates consisting of architects, engineers, contractors and all persons interested in any way in cement or its allied products.

We are arranging for special railway rates and it is hoped that delegates will come from points as far away as Vancouver and Halifax. We also expect a number of visitors from the United States. We are exerting every effort to make this coming affair one of the most successful ever held in Toronto. It will well repay persons living outside of Toronto to take advantage of this occasion to visit this convention and exhibition.

GLIDDEN VARNISH FINISH.

ALKALI-PROOF PAINTS and varnishes are in great demand nowadays to cover the unsightly exterior of a concrete wall.

Concrete floors require **DRESSING** to protect them against abrasion and wear.

LIQUID CEMENT is used for waterproofing concrete as well as for interior and exterior decoration. It assures a perfect bond to the concrete and produces very pleasing effects.

WHITE FINISH and **FRENCH CAEN STONE FINISH** are likewise extensively used, the latter in some of the most expensive hotels and bank buildings both in this country and abroad.

These and a number of other preparations are put upon the market by the well-known Glidden Varnish Co., of Cleveland, Ohio, who issue a pamphlet describing the varied uses of their justly famous products.

CONCRETE WEATHER BULLETIN.

The Portland cement manufacturer has certainly done his share in educating the consumer and in preventing him from making improper use of cement and from handling the material in a careless manner.

Almost every cement company in the country issues pamphlets to their customers which contain all necessary rules and advices and, in addition, include many valuable hints and, in many instances, even complete lectures on how to erect Concrete buildings and how to obtain best results.

If only one-tenth of the instructions given were followed by the customer, the number of failures would be greatly minimized. However, the practical cement worker is not always an ardent student of cement literature. Therefore, the manufacturer has conceived the idea to tie to every bag of cement a tag containing the most necessary instructions conforming with the season. The following is an example of this kind of bulletins which none but an absolutely reckless builder will disregard:

DON'T

let the weather deceive you—the days are warm, but the nights and mornings are cold.

COLD WEATHER

is not conducive to quick setting, and

LONG TIME SETS

mean slow hardening, thus reducing the strength of the concrete for a considerable period.

Mr. Contractor, as a Precaution

watch the weather—give your work ample protection, and—most important of all—heat the material and the water. This will insure satisfactory work.

CHICAGO

PORTLAND CEMENT CO.

General Offices:

108 La Salle Street, CHICAGO.

Mills: OGLESBY, ILL.

MR. POTTER, CHEMIST, RESIGNS.

N. S. Potter, chief chemist of the Western States Portland Cement Co., resigned, he will be succeeded by R. Robinson, chief chemist of the Sandusky Portland Cement Co., at Syracuse, Ind.

MR. WALTER BRINTON.

Mr. Walter Brinton, superintendent of the Manganese Steel department of the Taylor Iron & Steel Co.'s plant at High Bridge, N. J., since 1895, has resigned, and has accepted a position as consulting engineer for the Edgar Allen American Manganese Steel Company, who are manufacturing Manganese Steel at Chicago Heights, Ill., and at New Castle, Del. Mr. Brinton's headquarters will be at the New Castle plant.



Brooklyn, N. Y.

**Orenstein-Arthur
Koppel Company**

Gentlemen:

The plant purchased from you last May has given us complete satisfaction, and in many respects has surprised us.

The cars are easily handled and, although we have used them constantly, they are as good as ever.

The roller bearings are well worth the difference in cost. On several occasions, one team has drawn 20 empty cars up a 10% grade.

Should our recommendation be of any value to you, call on us.

*Respectfully,
Murphy Bros.*

Orenstein-Arthur Koppel Co.

Pittsburgh, Pa.

Branch Offices

New York
Chicago Baltimore
Philadelphia Boston
San Francisco
Denver



BONDING LAYERS OF CONCRETE.

In various forms of concrete construction the bonding of successive layers often becomes a matter of the most serious consequence and the difficulty attending it has often proven embarrassing, particularly where there have been unavoidable delays in the work. J. A. Jamieson, of Montreal, Canada, has developed a system for bonding layers of concrete which he has found highly satisfactory, having employed it with good results in a variety of work, including the construction of a reinforced concrete elevator and a reinforced conduit ten and one-half feet in diameter and 8,000 feet long, working under thirty-three feet head.

The surface of the concrete, approximately horizontal, is allowed to stand until water which may have flushed to the top has disappeared. When this result is attained, and while the mass is still moist, the entire surface is covered with a 1 to 1 dry mixture of cement and sand to a thickness of about half an inch. If necessary this is protected with tarpaulins of boards. The moisture on the fresh concrete produces a partial set in the dry mixture. This is true of the particles in direct contact with the green concrete, the effect diminishing rapidly and the upper portion of the dry mixture remaining unaffected. The next layer of concrete is applied without removing the dry layer, the moisture in the fresh concrete completing the set through the half-inch dry layer and producing a decided bond of the two courses. Briquettes made of cement mortar in two parts and joined by this method, developed a strength more than half as great as others made of the same material in a single piece. This would seem to be quite a satisfactory test.

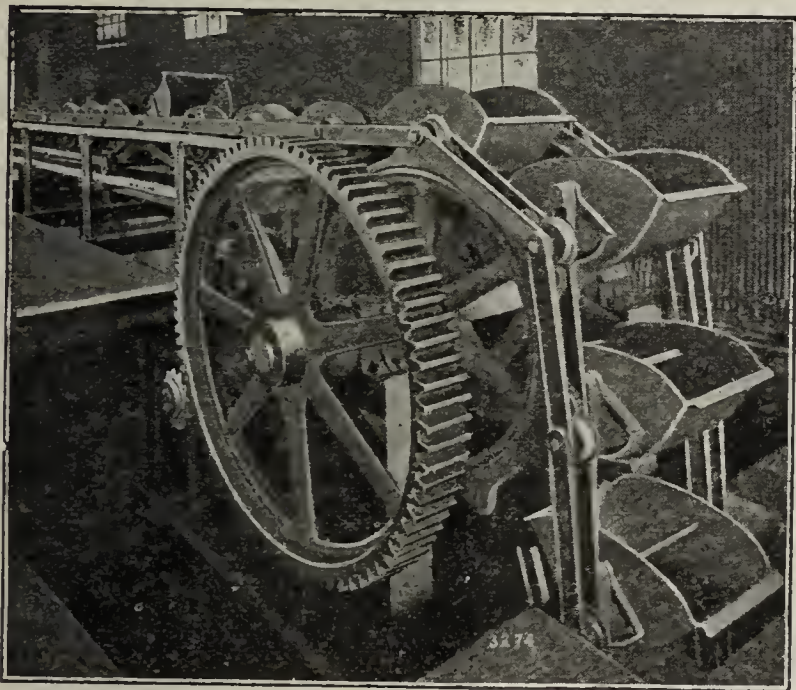
**NOTHING BUT CEMENT
CONSTRUCTION HERE.**

The town of Metaline, Wash., is developing rapidly as the plant of the Inland Portland Cement Co., approaches completion. The big cribbing at the shale quarries east of the power plant is about completed. These quarries will furnish the shale used in the manufacture of cement. The timbering and cement foundations for the two tramways for the company are nearly completed. The machinery for the cement plant is arriving. The huge dryer was received recently. It weighs 90 tons, and required four flatcars for its transportation. Every store, office and business building and dwelling in the town will be veneered with cement block, the product of the new \$1,000,000 plant. The sidewalks and curbing also will be of cement. The factory, which covers thirty acres, will be in operation in February. An electric plant, costing \$350,000, designed to generate 10,000 horsepower, is nearing completion. Two lumber yards have been opened and with all kinds of materials on hand there is much building activity.

Lewis P. Larson, of Spokane, owner of the town-site, was formerly a miner in Colorado and northern Idaho. He discovered vast deposits of materials for the manufacture of cement and lime on a heavily timbered mountain a year ago and was successful in interesting Pittsburg and Chicago capitalists, who are investing thousands of dollars in developing the district tributary to the new town.

PECK CARRIER

a conveyor-elevator consisting of malleable iron buckets
(that overlap on the horizontal runs) attached to roller chains.



Descending turn of PECK CARRIER showing bucket on horizontal run tilted into emptying position.

The corner turns are made around wheels—just a simple change from one run to another without interfering with the natural carrying position of the buckets.

For rules of correct conveying, as well as descriptions and views of various installations, see our Book No. 81. Address nearest Office.

LINK-BELT COMPANY
PHILADELPHIA **CHICAGO** **INDIANAPOLIS**
 NEW YORK, 299 Broadway
 PITTSBURGH, 1501-2 Park Building
 ST. LOUIS, Central National Bank Bldg.
 SEATTLE, 439-440 New York Block
 DENVER, Lindrooth, Shubart & Co.
 NEW ORLEANS, Wilmot Mch'y. Co.
 SAN FRANCISCO, Eby Machinery Co.

CONCRETE RESERVOIRS.

The Weber-Duller Company of Houston, Texas, have just received the contract to construct two concrete oil storage reservoirs in California of 1,000,000 barrels capacity each. They will be 600 feet in diameter and 20 feet high.

RIVERSIDE PORTLAND CEMENT COMPANY ENLARGING ITS PLANT.

The Riverside Portland Cement Co., Riverside, Calif. has had plans prepared for the enlargement of the plant at Crestmore. The addition will be of reinforced concrete, and 4 new kilns, 8 ball mills and 10 tube mills will be installed; about \$300,000 worth of new machinery will be needed. In all about \$400,000 will be expended in the improvements.

ANNOUNCEMENT.

During the next year, we are going to continue to publish the most noteworthy papers of the European cement literature.

The January and February issues, for instance, will contain an essay by Kaiserman covering the latest researches on the hardening process and on the constitution of cement. This experimenter succeeded, by an entirely novel method of microscopic research, in establishing in a convincing manner the identity of the various crystals and colloidal bodies forming in hardening cements. From these he drew conclusions as to the composition of Portland cement clinker, which he recognized to be a mixture of di-calcium silicate and tri-calcium aluminate without uncombined lime. In the face of the many vain efforts made in the past with a view to following the process of hydration, the results obtained by Kaiserman's method of investigation will astonish the reader and show him, that all that was hitherto lacking was the finding of the right way in which to approach the problem. The nature of the different kinds of crystals observed in hydrating cements was established one by one, through comparison with hydrating calcium silicates and calcium aluminates of known composition, and the cementing substance proper turned out to be colloidal calcium-silica-hydrate. Alumina and iron oxide did not contribute to the hardening, as the former was found to be contained only in readily soluble crystals and as the latter

was not acted upon at all by water. This work is an excellent supplement to Unger's, Schott's and Day & Shepherd's researches on the constitution of the clinker and verifies Michaelis' statements about the colloidal nature of cements.

In our March issue, we shall publish a paper on puzzuolana-mortars by Professor van der Kloes of the University of Delft, Holland, who is an authority on puzzuolana materials. He advocates the use of puzzuolanas in connection with slaked lime or with Portland cement, but condemns the common practice of mixing Portland cement with slaked lime for the sake of obtaining mortars that work readily under the trowel and that are cheaper than pure Portland cement-sand mortars. He illustrates the disadvantages accompanying the application of mortars of faulty composition and points out numerous cases in which this practice led to decay of brickwork and stone masonry and to gradual corrosion of the whole structure.

A number of the following issues will entertain the reader with abstracts from Mr. Leduc's excellent work on Sand-Lime Brick. This French expert on mortar materials is practically the only person who, during the thirty years of the existence of the product, made exhaustive scientific researches covering the raw materials, the physical conditions, the intensity and duration of pressure during moulding and afterwards in the hardening cylinder, the influence of the atmosphere, upon the unhardened and hardened brick, briefly every possible phase in the manufacture of this modern building material. In opposition to almost all other publications on sand-lime products, which are mostly written with the exclusive intention of selling machinery or disposing of the rights to manufacture sand-lime brick under certain systems, this work by Leduc is of a strictly scientific nature, absolutely impartial and up-to-date in every respect. We feel sure that a publication of its most prominent chapters will be highly welcomed by many of our subscribers, who asked us often during the past years to supply them with English literature covering the subject and to whom we had to reply that no books existed in the English language dealing with the sand-lime brick industry, except a few pamphlets issued by manufacturers of machinery.

The work of translating these master-pieces in our art will be undertaken by Dr. W. Michaelis Jr., to whom many American cement men are greatly indebted for having introduced them heretofore to a great number of valuable foreign publications, which would have otherwise remained to them a closed book.

FOR SALE CHEAP

Two New No. 66 Lindhart Kominuters
Five No. 7 Schmidt Ball Mills
One No. 64 Lindhart Kominuters

The above equipment is in first-class condition

Address : **COPLAY CEMENT MFG. CO., - - Coplay, Pa.**

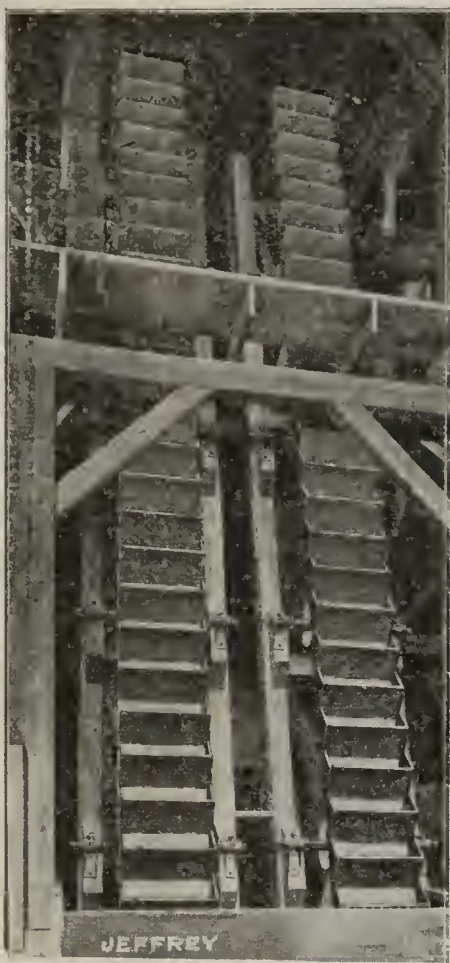
LEHIGH PORTLAND CEMENT



HIGH TENSILE
STRENGTH
FINELY GROUND
LIGHT
AND UNIFORM
IN COLOR

Manufactured by
The Lehigh Portland Cement Co.
ALLENTOWN, PA.

Western Office:
725 ROCKEFELLER BUILDING,
CLEVELAND, OHIO.



Jeffrey Elevators Handling Crushed Stone

Jeffrey Elevators AND CONVEYERS

for handling your raw and finished products from the crushers and bins with the least trouble and expense.

We solicit an opportunity to demonstrate the most practical conveying equipment for your needs.

We also build Pulverizers for crushing cement rock.

Send for our Catalog 81.

THE JEFFREY Mfg. Co.
COLUMBUS, Ohio.

Chicago
St. Louis
Denver

Montreal
Pittsburg
Charleston, W. Va.

Boston
New York
Birmingham

Visit Jeffrey Exhibit, New York Cement Show.

ALPHA PORTLAND CEMENT....

Quality unexcelled The Recognized Standard American Brand Always Uniform

ALPHA PORTLAND CEMENT CO.

Alpha, N. J.
Works: Martins Creek, Pa.
Manheim, W. Va.
Alsens, N. Y.

Manufacturers of but one grade—strictly straight Portland
General Office, EASTON, PA.



Humane Double - Action Trowel

1. Finishes both ways.
2. Does as much work in two hours as a man can do in ten hours the old way, and does it BETTER.
3. Write for prices and literature. Use coupon, postal or letter and address nearest office below.

The Humane Horse Collar Co.

702 Lowe St., Chicago Heights, Ill.

Send me price and all literature on your new
Humane Double-Action Trowel.

Name

Address

Town

State

Peerless Portland Cement

MANUFACTURED AT UNION CITY, MICH.

Every Barrel Guaranteed

Fineness, Uniformity of Color and Sand Carrying Qualities equal to any Portland Cement Manufactured



TRADE MARK

PENINSULAR PORTLAND CEMENT

Acknowledged by competent Architects and Engineers to be unequalled for fineness, wonderful development of strength and sand carrying capacity.

"THE BEST IS THE CHEAPEST"

Address

Peninsular Portland Cement Co.
JACKSON, MICHIGAN.

Improved Canvas Stitched Belting



We Specialize in making Belts for use in Cement Plants.

Light or Heavy Transmission, Elevator or Conveyor Belts for Wet, Dry, Hot or Rough conditions.

Sawyer Belting Co.

Cleveland, O.

Send for Book "K."

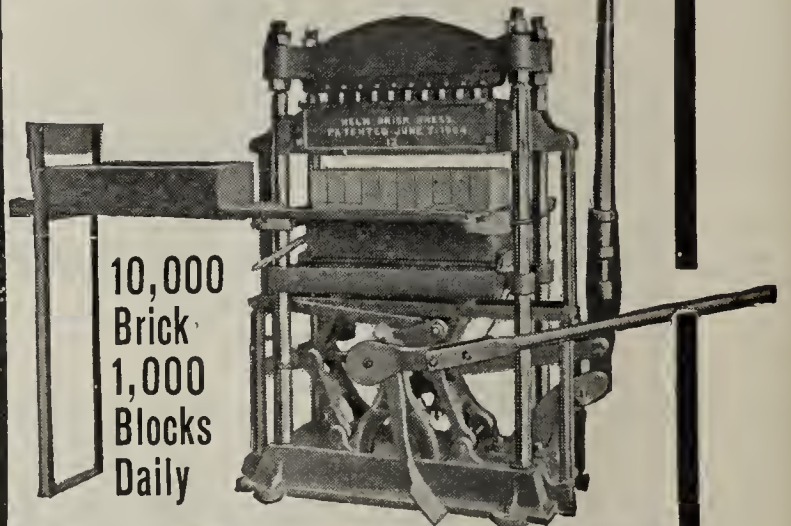
BIG MONEY FOR YOU

In Pressed DRY-WALL Blocks and Brick

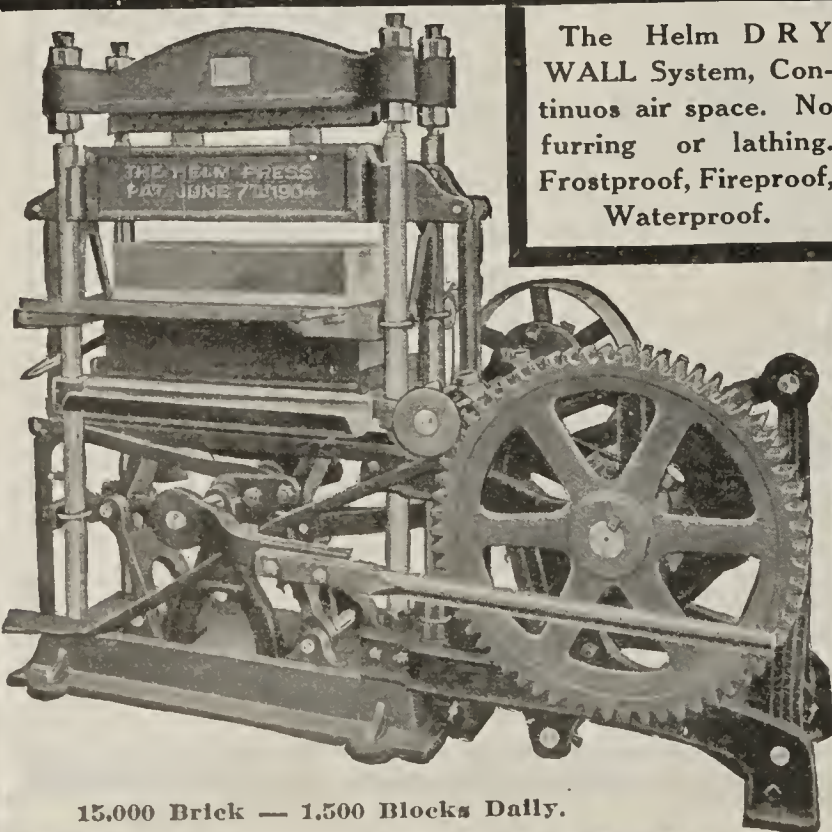
Helm Presses make as high as \$50.00 daily. You can secure the cream of the concrete business with their superior product. Unequalled for beauty, strength, adaptability and cheapness. Daily displacing machines of every description.

The 80,000 lbs. pressure of Helm Brick and Block Presses make the strongest and most uniform concrete product. A 6 to 1 brick only 27 days old stood 85,000 pounds compression, for excelling all other tests. Heavy pressure on medium wet concrete secures this wonderful result with the least cement. A Helm Press and the medium wet mix is the only sure and certain method. You're bound to adopt it in the end. You'll save money by adopting it now. No "extras" to buy with Helm outfits.

80,000 lbs.
Pressure

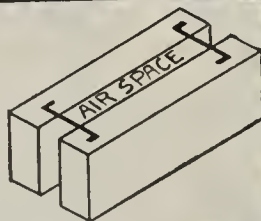


10,000
Brick
1,000
Blocks
Daily



15,000 Brick — 1,500 Blocks Daily.

The Helm DRY WALL System, Continuous air space. No furring or lathing. Frostproof, Fireproof, Waterproof.



Investigate the Helm Hand and Power Presses

if you want to control the big contracts in your locality. You can outstrip competition. You can manufacture cheaper, make better product and get better prices and more business.

Send the Coupon for free Concrete Book

Profusely illustrated with half-tones and diagrams of machines, product and building forms. Shows how to secure dry walls. Don't buy without first getting this book. Send the coupon right now for your copy, free and prepaid.

HELM BRICK MACHINE COMPANY,
214 Bank Building, Traverse City, Mich.

HELM BRICK MACHINE COMPANY,
214 Bank Bldg., Traverse City, Mich.

Send me the free book on concrete. Interested in ☐ Blocks, ☐ Brick, ☐ Mixers.

NAME

ADDRESS

Glidden's Waterproof Concrete Floor Dressing

Will protect Cement floors from Disintegration, Abrasion, Wear, Dusting and Absorption of Moisture, Oil, Grease and Disease Germs.

Wonderful Transformation. Small Expense.

Sample and full information, gratis, upon request.

Our Booklet covering

ADVANCED FINISHES FOR MODERN BUILDING
CONSTRUCTION

will be forwarded, gratis, upon request.

The Glidden Varnish Company

Factories : CLEVELAND, OHIO. TORONTO, ONT.

Branches :

ATLANTA.

BOSTON.

CHICAGO.

NEW YORK.

ST. LOUIS.

IT WILL PAY YOU TO USE CROWN HYDRATE

(HIGH CALCIUM HYDRATED LIME)

For Waterproofing and Concrete

It Improves Its Strength and Color. Ask the

Marblehead Lime Company

KANSAS CITY

CHICAGO

Wet Process Concrete Blocks

By the Pettyjohn System

The manufacturing of Concrete Blocks is rapidly nearing perfection, but the up-to-date manufacturer must use modern machinery and employ improved methods. Three features are important in perfect block making:

Wet Process

Face Down

Damp Curing

These splendid features are combined in the new Pettyjohn Invincible Machine, and no other. Made in three lengths 16-inch, 24-inch and 40-inch. Tandem Invincible makes two blocks at once. Price \$65 and up. Single Invincibles, \$35 and up. Sold on trial always, guaranteed to give satisfaction or money refunded.

With our **TRIPLE TIER RACKING SYSTEM** green blocks can be stacked three high direct from machine with inexpensive home-made rigging. This economizes space, reduces off-bearing distance, and above all insures slow, even, damp, perfect curing and bleaching. Plans and blue prints free to customers.

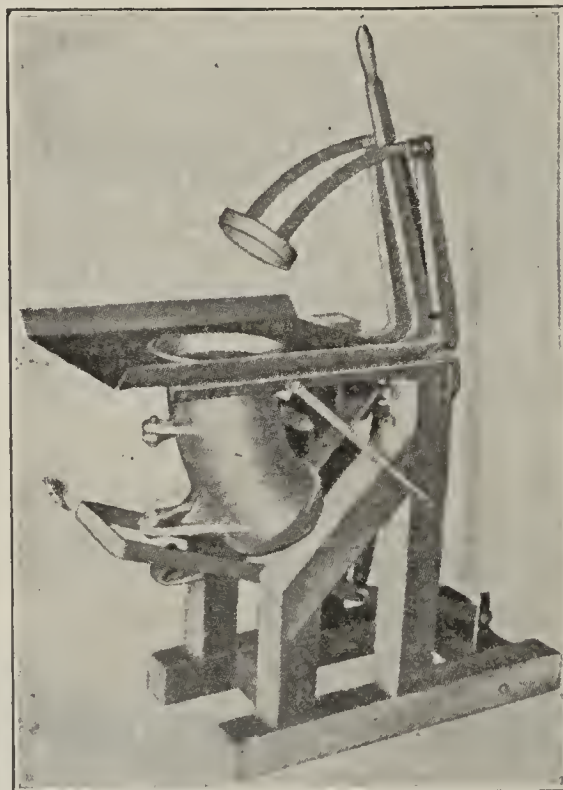
Send for our latest edition of "Stone Making" (just published), a book of valuable data for the block maker—FREE.

THE PETTYJOHN COMPANY - - 645 No. Sixth St., Terre Haute, Ind.

Concrete Sewer Pipe Bends

The Only Machine
of Its Kind
on the Market.

Concrete Sewer Pipe
Bends Made on the
**RICKMAN SEWER PIPE
BEND MACHINE** Make
Money for the Manu-
facturer.



The Latest Thing
Added to the Concrete
Machinery Line.

ONE MAN can make from 15 to 20 curved sections of pipe per hour. Shovel in the material, tamp it with the tamping ring, operated by foot lever, attach the bell-end form, complete the section, withdraw core from below, by lever, carry the pipe away to a pallet and bring the outer mold back to the machine.

You Need This Machine to Complete the Equipment of Your Tile Factory

Write for Circulars and Prices

R. L. RICKMAN CO.,

987 Westminster Avenue,
VANCOUVER, B. C.

RAILS! RAILS!! RAILS!!!

New and Second Hand for Track and Building Purposes, cut to any lengths. Delivered to all parts of the United States.

BLOCK POLLAK IRON COMPANY

Gen'l Offices—First National Bank Bldg., Chicago.

Offices:
Cincinnati, Ohio
St. Louis, Mo.

WE SAVE YOU MONEY.

—STEEL PILING—

NEW and SECOND HAND, Various Lengths

PRICES VERY LOW

WALTER A. ZELNICKER SUPPLY CO. IN ST. LOUIS

Rail, Equipment and Heavy Machinery Bulletin now Ready

Self-Lining, Interlocking Concrete Blocks

Can Be Laid in the Wall at One-half the Expense of Ordinary Blocks

See how they fit together at ends, top and bottom. Lay the first course straight and level and all the other courses in the wall must be the same without the use of line or level. Any intelligent man can lay them. No high-priced mechanics required.

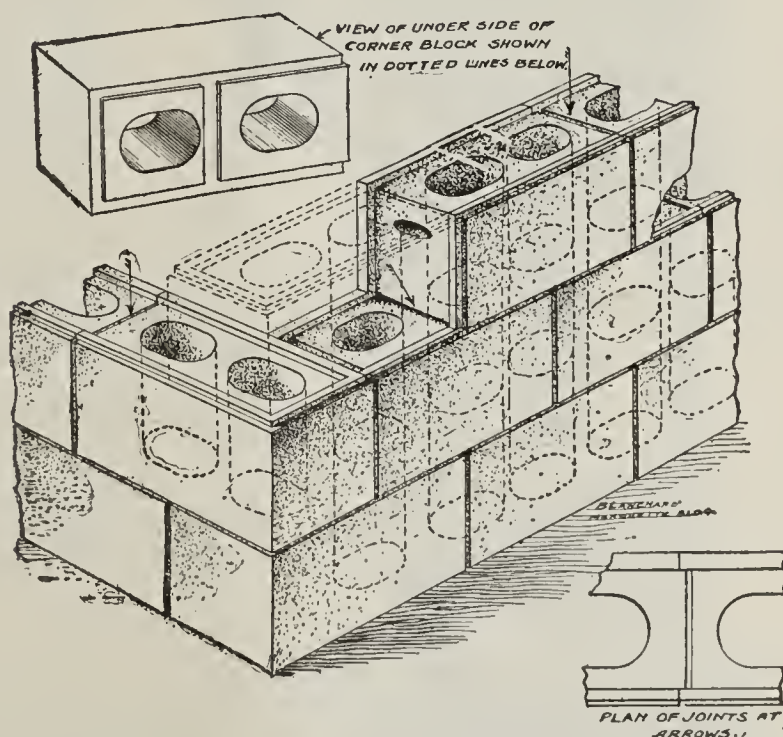
The mortar is retained between the ridges and cannot run over the face of blocks. Opening is left at outside joints for tuck pointing. Saves over half the tuck-pointing expense. Inside joints are tight.

Revolutionize the Block Business

Made on our Patent Automatic Acting
Face-Down Machine by the Wet Process

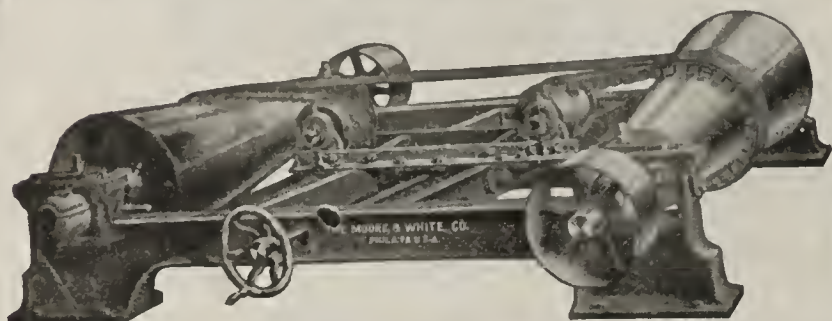
The block is delivered on pallet, mould released, and cores withdrawn downward by one action of the levers. Will turn out one-fourth more blocks in a day than any other machine on the market.

Costs no more than other machines. Exclusive territorial rights GIVEN with sale of machines. Let us tell you more of its good points. Salesmen and agents wanted in all states and foreign countries.



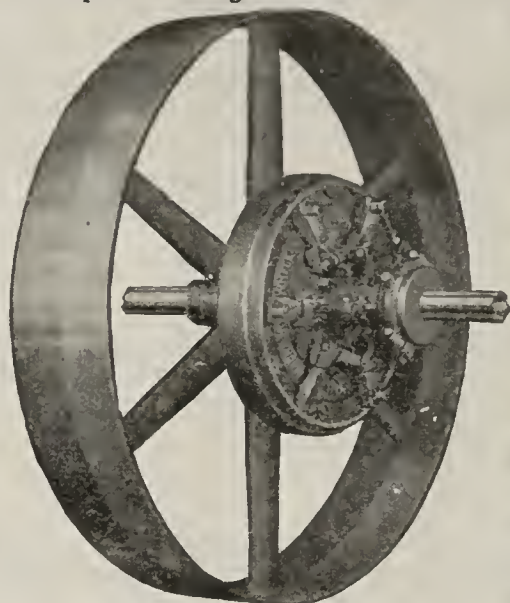
DIAMOND CONCRETE MACHINERY COMPANY
CARDINGTON, OHIO

It will be to any Mill Owner's advantage to investigate these two economical Power devices.



M. & W. Speed Change.

Power
Transmission
Machinery
for
Cement
Mills.



Friction Clutch Pulley.

Write for

Catalogue.

The Moore & White Co.,
Philadelphia, Pa.



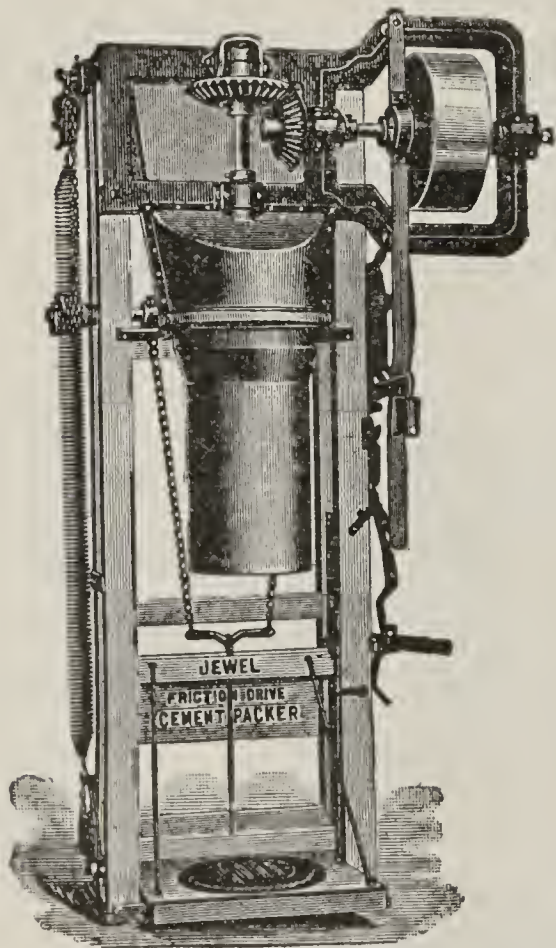
Promptness
in shipments is of vital importance to the cement user whose storage capacity is usually limited and whose work is so frequently dependent upon weather conditions. The big output of this Company, our enormous storage bins, the location of our mills near large centers of population where abundant labor may be had, where large car supplies are available, where connections with the numerous railroads entering Chicago and Pittsburg can be made readily—an efficient Traffic Department service—these form the basis of our reputation for quick shipments.

Universal Portland Cement Co.

Chicago—Pittsburg

Annual Output 8,000,000 Barrels

There is more Cement being packed by the "S. HOWES" Company's Packers than ALL OTHER Makes Combined.



The IRON KING Cement Packers for Packing barrels and sacks.

The "JEWEL" FRICTION driven cement Packer, specially constructed for rapidly packing sacks.

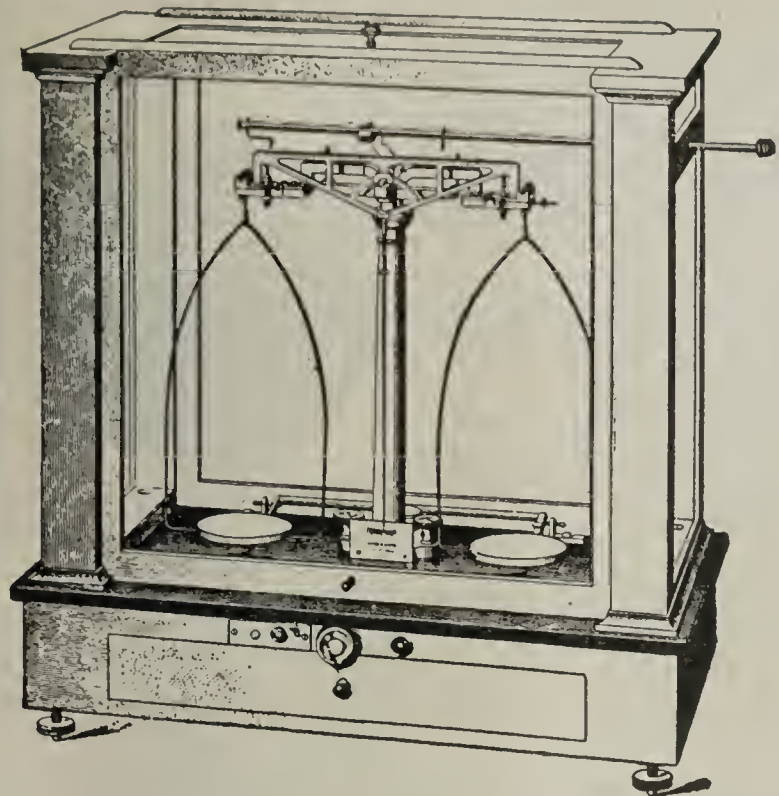
Both machines are equipped with friction pulleys, heavy iron frames which carry all the working parts.

Are strong constructed throughout. Guaranteed fastest and most durable machines offered for the purpose.

Write for full particulars.

The S. Howes Company
SILVER CREEK, N. Y.

Apparatus for Chemical and Physical Testing of Cement



EIMER & AMEND

205-211 Third Avenue, New York City

MANUFACTURERS OF & HEADQUARTERS FOR

Chemical Apparatus, C. P. Chemicals and Reagents

Cement Briquette Moulds.

Gilmore Needle.

Standard Sieves of Exact Meshes.

Williams' Sp. Gr. Balance.

*Specially adapted for determining
Sp. Gr. of Cement.*

(Descriptive Pamphlet sent on request)

*Schumann's, Le Chatelier's,
Jackson's and Candelot's
Apparatus for Sp. Gr. of
Cement.*

Headquarters for **Calorimeters and Pyrometers.**

(Our large illustrated Catalogue gladly sent to Chemists on application.)

F. A. Jones, M. E. Gypsum Specialist

Consulting, Mechanical and Chemical Engineer, in
Designing, Construction and Operation of Plaster
Mills, (Kettle or Rotary Process), Elevating, Coney-
ing and Crushing, Mechanical Drying, (Kiln or Rotary)
and Hydrating Plants, Power Houses, Pumping Stations
and Water Powers.

Examination, Tests, Analysis and Reports, Plans,
Specifications and Superintendence of Construction.

No. 311-C FEDERAL BLD'G.
YOUNGSTOWN, OHIO.

WM. B. SCAIFE & SONS CO.

221 First Ave., Pittsburg, Pa.

WE-FU-GO

and **SCAIFE**

Water Softening, Purifying, and Filtering Systems

— FOR —

BOILER FEED

AND EVERY INDUSTRIAL USE.

Send for Complete Information

DEXTER Portland Cement

THE NEW STANDARD

Sole Agents **SAMUEL H. FRENCH & CO.** Philadelphia



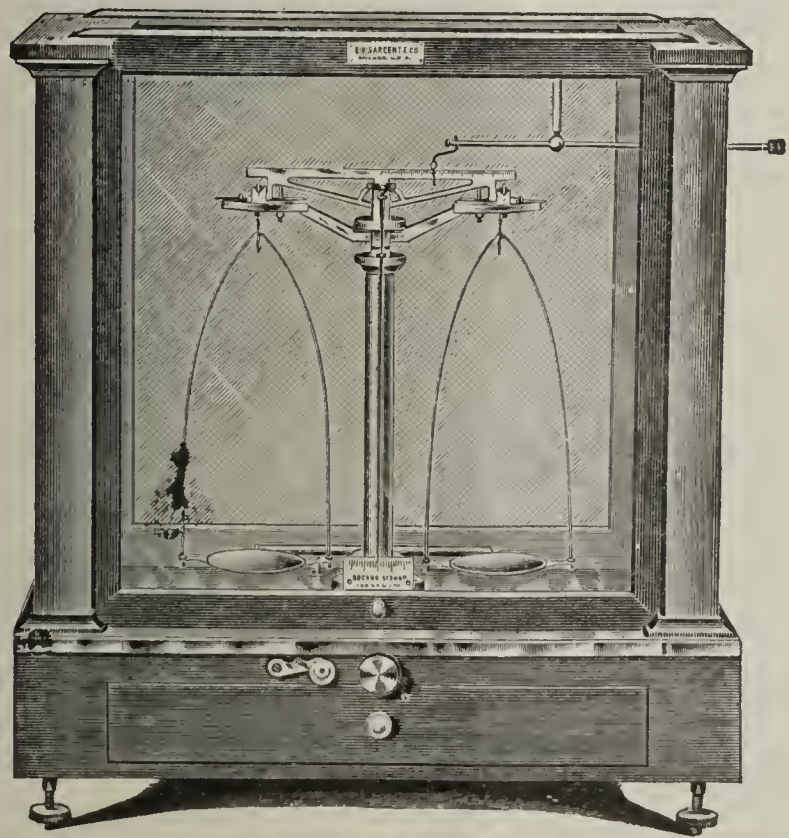
OWL CEMENT

GERMAN AMERICAN
PORTLAND CEMENT WORKS

E. L. COX,

GENERAL SALES AGENT

1527 Marquette Bldg. CHICAGO, ILL.



E. H. SARGENT & CO.

(Established 1852)

IMPORTERS, MAKERS AND DEALERS IN

CHEMISTS SUPPLIES

Of high grade only.

We call particular attention to our Cement
Mould, Vicat Indenting Apparatus, as im-
proved by us, Gilmore's Needles, Jackson's
specific gravity apparatus, etc.

We send catalogue without charge to responsible parties.

143 and 145 Lake St.

CHICAGO



Medusa White Portland Cement

Used for entire exterior plaster of
Ritz Hotel, San Francisco,
Cal., here illustrated.

A beautiful product adapted to
ornamental artificial stone work
of the highest grade. Equal or
superior to any other White Port-
land Cement known.

Write for free sample, pamphlet
with instructions for use and price.



MEDUSA WATERPROOFING

(Patented Apr. 23, 1907)

Makes concrete impervious to water and prevents ef-
florescence and discoloration. Gives absolutely perma-
nent results and does not affect strength, setting or
color of Portland Cement.

Used by nearly all the foremost Engineers, Architects,
Railways, Contractors, Block Makers and Cement
Experts.

Obtain our price and circular, also price on Medusa
Gray Portland Cement.

SANDUSKY PORTLAND CEMENT Co., Sandusky, O.

"VULCANITE" PORTLAND CEMENT

MAIN OFFICE

Land Title Building
PHILADELPHIA

SALES OFFICE

Flat Iron Building
NEW YORK

PORTLAND CEMENT

WATERPROOFING COMPOUND

Seven Cents per lb. F. O. B. any R. R. Station

We suggest and invite comparison of the unsolicited test reports of cement treated
with our product to those of all others combined.

We Loan Free of Charge a Simple Mixing Machine.

**McCORMICK WATERPROOF
PORTLAND CEMENT CO.**

BANK OF COMMERCE BLDG., ST. LOUIS, MO.

(HIGH CLASS TRAVELING REPRESENTATIVES WANTED.)

The Fuller Engineering Company

Designing, Constructing and Operating Engineers

Cement Plants a Specialty

Reports, Examinations and Analyses of Raw Materials for Cement
Consultations Solicited.

Offices: Allentown Nat'l Bank Bldg.,

Allentown, Pa

Position Wanted.

Have had fifteen years experience in Cement plants, wet or dry cement rock, or stone and clay or shale. Am open for position. Moderate salary. Address W. S. P., care Cement & Eng. News.

Am prepared to do remodeling work for any Cement mill, not regularly employing engineer. Thoroughly competent, large experience. Terms moderate. Address Engineer, c/o Cement & Eng. News.

Wanted.

A General Plant Manager in the east with experience and ability, familiar with Cement and Lime manufacture. To the right man a fixed position with salary of about \$5,000 per year.

Answer, giving full particulars as to age, past and present employment, actual experience, etc., and references. Only applications from the most experienced and competent will be considered. Address Box 25, c/o Cement & Engineering News.

Wanted.

First class mechanical engineer, capable of general supervision over several cement plants. Experienced in design, construction and operation. State record, and salary expected. Address Manufacturer, c/o Cement & Engineering News.

Position Wanted.

Operating Cement Mill Foreman and burner, desires to change position. Can furnish references and show letters of recommendation from former employers. Address R. G. L., care Cement & Engineering News, Chicago, Ill.

WANTED.

Experienced salesman with wide acquaintance among cement companies, to sell Manganese Steel Repair Parts. Technical Graduate preferred. Address S. M., care Cement & Engineering News.

WANTED

the services of a representative to look after our old customers and prospective buyers of our Modern Simple Tax-free Industrial Alcohol Distilling Apparatus, by special successful demonstrative methods for making Aguardiente, Mes-cal, Tegulla, Peach Brandy, Solidified Alcohol in Cubes, Denatured Alcohol. Most modern simple 5 Gal. Still and all Sizes to 500 Gal. daily Capacities. Good Commission. Address

The Wood Waste Distilleries Co., Inc.
Wheeling, W. Va., U. S. A.

Iron-Ore Cement

The only reliable cement for marine construction.

A cement which resists sea water and is proof against refuse water of mines and all liquids containing sulphates.

Manufactured on strictly scientific principles.

Iron-Ore Cement is used exclusively by the German Government in place of Portland cement for all Marine Construction.

Send for Literature, Etc.

WORM-COX COMPANY

SOLE AGENTS

Marquette Building, Chicago

Denatured Alcohol in Solid Form.

Cleveland Special Dispatch Sept. A well known Wheeling, W. Va., chemist has succeeded in producing chunks of denatured alcohol in crystal form by means of a small infusion of certain acids whereby crystals of an alkaloidal nature very closely resembling physiologically the effects of ethyl alcohol distilled from saw dust. The method employed and the results obtained are somewhat similar to the crystalizing of rock candy or that of Saccharine, containing as it does, 350 times the sweetening strength over that of cane sugar, so this alkaloidal crystalized alcohol contains many times the strength over the ordinary denatured fluid alcohol they will yield 194 proof denatured alcohol with a greater heating and cooking power for stoves than gasoline and it is absolutely non-explosive.

A sample case containing 50 solid cubes, a stove and the secret formula, how simple it can be made at home, will be mailed to you post paid on receipt of \$5.00, or C. O. D. Address:

THE WOOD WASTE

DISTILLERIES Co., Inc.

Dept. C. Wheeling, W. Va., U. S. A.

Waterproof Your Block by using a Wet Mixed Mortar Rammed by Hydraulic. It Produces a Dense NON-ABSORBENT Fireproof Concrete Product.

Protect yourself with QUALITY CONCRETE. Protect yourself from COMPETITORS. We will protect you by our PATENTS from a COMPETITOR. We will protect you with the ONLY HIGH CLASS CONCRETE POWER MACHINERY on the MARKET.

With QUALITY, QUANTITY, SCOPE and PROTECTION, "You will lead". Let the eye SEE, the hand FEEL, "CONCRETE" not that which has been called concrete, but DENSE STRONG TRUE CONCRETE.

We are willing and desire to SHOW YOU, and don't BUY UNTIL YOU ARE SHOWN. Ask for our literature.

FISHER HYDRAULIC STONE & MACHINERY COMPANY

FACTORY AND OFFICE:
MT. GILEAD, OHIO.

CHICAGO, ILL., OFFICE:

192 MICHIGAN BOUL.

WICHITA, KANSAS, OFFICE:

I. F. WEST, MANAGER.

BALTIMORE, MD., OFFICE:

34 BUILDERS EXCHANGE BLDG.

The Giant Griffin Mill

40-inch Die 24-inch Roll

15,000 lbs. Crushing Effect

Will take Portland Cement clinker
1½ inches diameter from the kiln
and deliver a finished product.

85 to 87% through 200 mesh screen.

13 to 15 bbls. per hour.

50 to 55 horsepower.

Limestone, 5 to 8 tons per hour.

Coal, 5 to 6 tons per hour.

Other materials in proportion.

It saves cost in buildings.

It saves cost in installation.

It saves cost in power.

It saves cost in repairs.

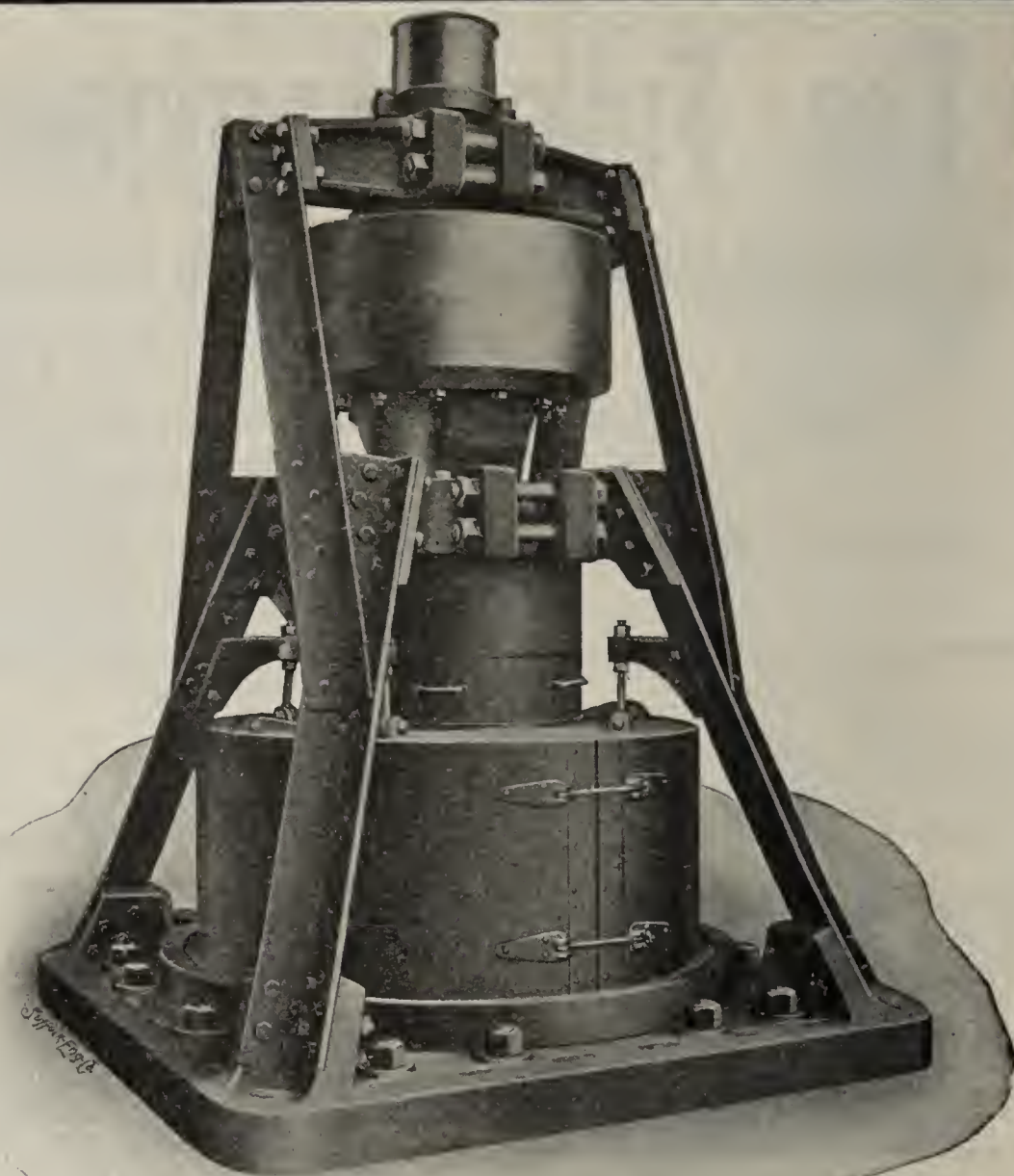
It saves cost in attention.

MANUFACTURED BY

BRADLEY PULVERIZER CO.,

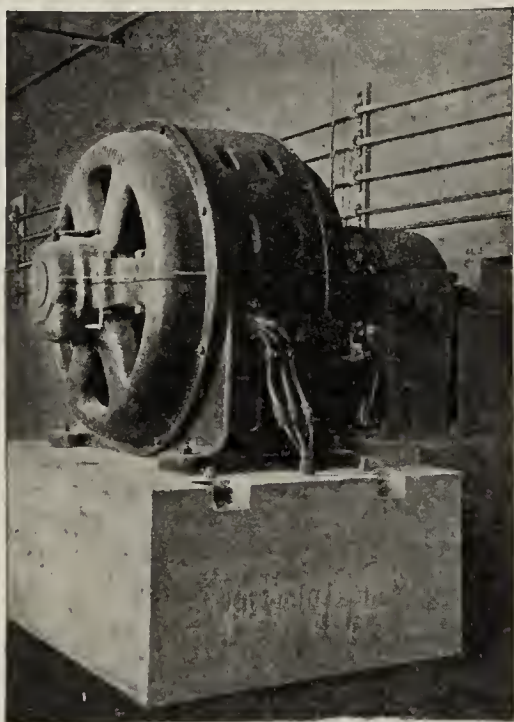
37 Walbrook
LONDON, E. C.

92 State Street
BOSTON



Electric Drive in Cement Mills

and how to accomplish it most efficiently and economically, are subjects the Westinghouse Company has thoroughly investigated.



Westinghouse Tube Mill Motor

Westinghouse Cement-Mill Motors

are designed especially to meet these requirements. Sturdy mechanical construction, high starting torque, ability to withstand the constant presence of dust and dirt are among their qualities.

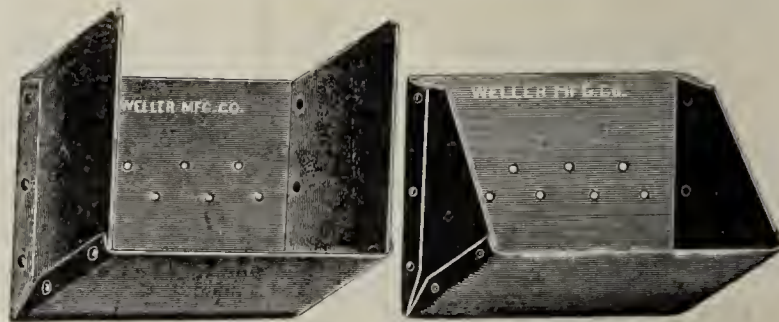
Westinghouse Electric & Mfg. Co.

Sales Offices in all Large Cities

Pittsburg, Pa.

WELLER-MADE

Steel Stone & Ore Elevator Buckets



We manufacture a complete line of elevator buckets for heavy service, and are prepared to furnish special sizes, shapes and gauge of metal to order on short notice.

ELEVATING, CONVEYING and Power Transmitting Machinery

The Weller line of machinery comprises everything for handling heavy materials rapidly and economically. Efficiency has been proven by service.

WELLER MFG. CO., Chicago

THE FREEBORN Engineering & Construction Co.

(Incorporated)

Engineers & Contractors

**Design, Construction, Remodeling and Operation
of Portland Cement Plants**

a Specialty

SCARRITT BLDG.

KANSAS CITY, MO.

JNO. J. CONE

ROBERT W. HUNT

JAS. C. HALLSTED

D. W. McNAUGHER

ROBERT W. HUNT & CO., MILL INSPECTION OF CEMENT

BUREAU OF INSPECTION, TEST AND CONSULTATION AND DESIGNING OF CEMENT PLANTS, CHEMICAL ANALYSIS, PHYSICAL TESTS

90 West Street New York Canadian Express Bldg., Montreal, Can. 1121 The Rookery Chicago 425 Washington St. San Francisco, Cal. Monongahela Bank Bldg. Pittsburgh Syndicate Trust Bldg., St. Louis, Mo. Norfolk House, Cannon St. E. C., London

The Osborn Engineering Co. Civil, Mechanical and Electrical Engineers OSBORN BUILDING, CLEVELAND, O. Experts in the Designing of **CEMENT PLANTS.**

Plans, Specifications, Estimates of Cost, Superintendence of Construction, Examination and Reports of Cement Properties, Tests and Analyses of Cements and Cement Materials.

Henry S. Spackman Engineering Co.

Formerly

LATHBURY & SPACKMAN, Inc.

Consulting Engineers and Experts

For the Erection, Designing and Operation
of Cement Works, Improvement of Old
Plants, Full Investigation and Report on
Cement Properties, Tests of Cements.

Importers and Exporters of Cement Machinery

42 NORTH 16TH STREET

::

PHILADELPHIA, PA.

HUNT ENGINEERING COMPANY

Iola, Kansas

Cement Engineers

Just Out!

Architects' and Engineers' Hand Book on
**Reinforced Concrete
Construction**

ONLY ONE DOLLAR

CEMENT & ENGINEERING NEWS

22 Fifth Avenue, Chicago

COLONIAL TRUST AND SAVINGS BANK

205 La Salle Street, CHICAGO

Capital and Surplus \$1,100,000.00

We are offering High Grade Seasoned 5 to 6% Bonds at attractive prices.

Particulars upon Application



THE IMPROVED DIETRICH'S CLAMP

and Form System for Hollow Walls

By the use of the Improved Dietrichs Clamp and Form System for Hollow Walls the

COST OF CONCRETE CONSTRUCTION IS REDUCED 50%

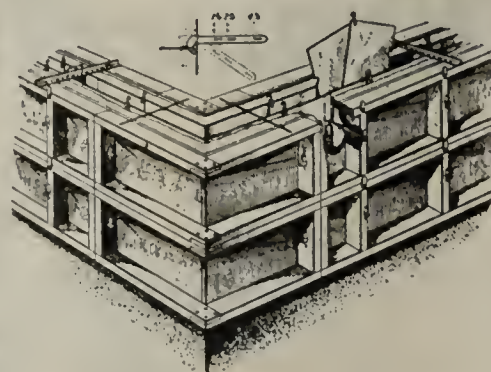
and the builder also secures a

PERFECT DAMP-PROOF WALL

This system is based on the panel principle and employs removable sheet iron inner forms with sheet iron spacer. Corners, doors and window openings are provided for.

Write for pamphlet giving full information

DIETRICH'S CLAMP CO.
LITTLE FERRY, N. J.



ELEVATING—CONVEYING MACHINERY



SPIRAL CONVEYOR

— MANUFACTURERS OF —

Belt Conveyors, Friction Clutches, Rope Drives, Pulleys, Shafting, Shaft Bearings, Link Belting, Special Chains



HEAVY BUCKETS

SEND US YOUR SPECIFICATIONS FOR ESTIMATES.
Catalog for the asking.

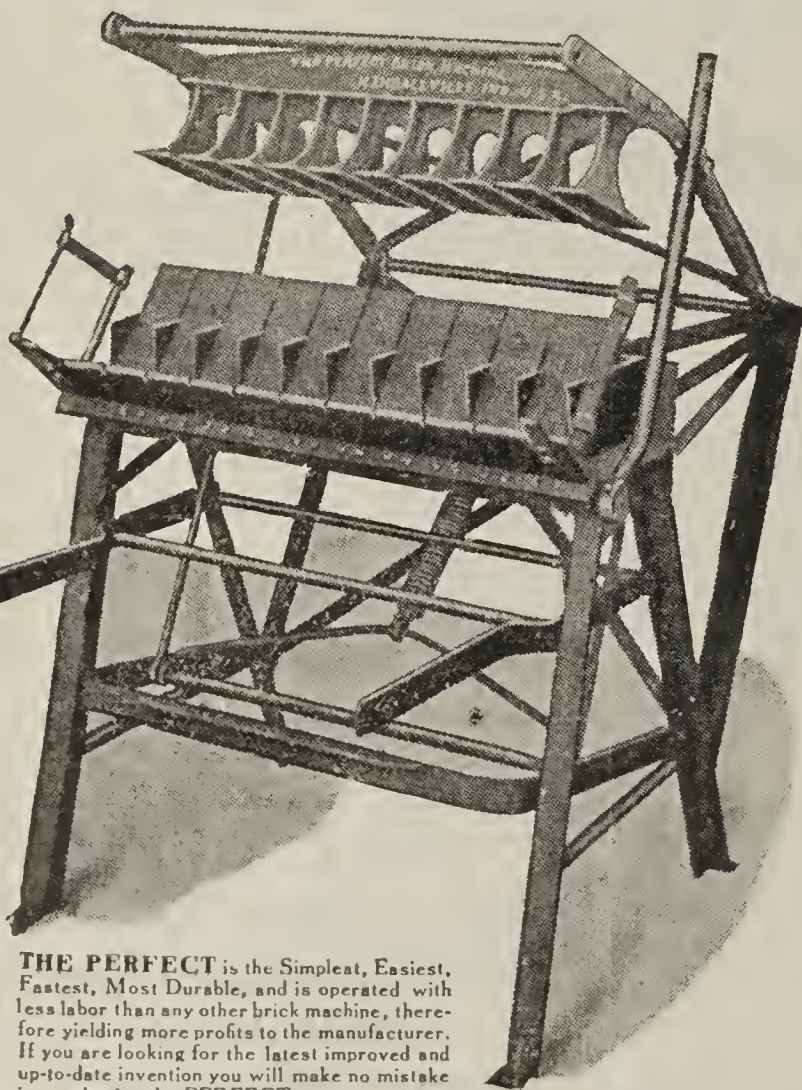
SKILLIN & RICHARDS MFG. CO., CHICAGO

THE PERFECT BRICK MACHINE

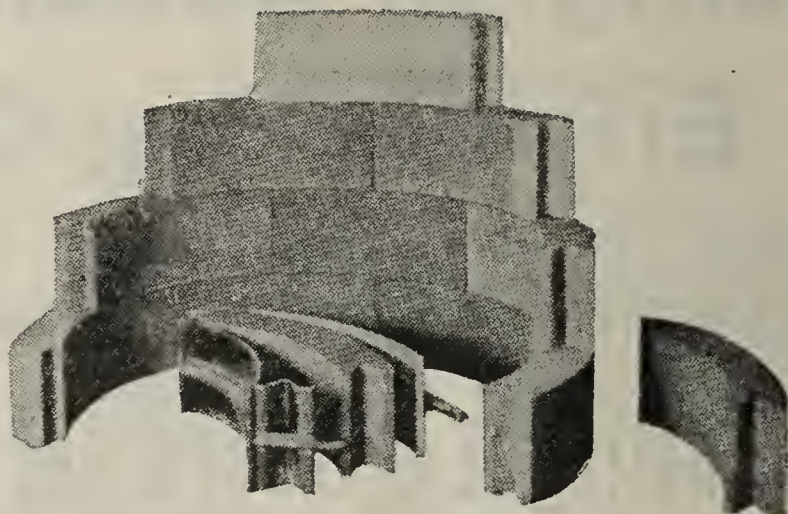
THE PERFECT CISTERN AND SILO MOLDS

ARE USED IN ALL PARTS OF THE WORLD

OUR MOLDS are the BEST and CHEAPEST ever offered to the public



THE PERFECT is the Simplest, Easiest, Fastest, Most Durable, and is operated with less labor than any other brick machine, therefore yielding more profits to the manufacturer. If you are looking for the latest improved and up-to-date invention you will make no mistake in purchasing the PERFECT.



The Perfect Well, Cistern and Silo Mold.

HERE IS OUR PRICE LIST

No 3 Circle Mold is 3 ft. diam.	No. 10 Circle Mold is 10 ft. diam.
" 5 " " 5 ft. "	" 12 " " 12 ft. "
" 7 " " 7 ft. "	" 14 " " 14 ft. "
	" 16 " " 16 ft. "

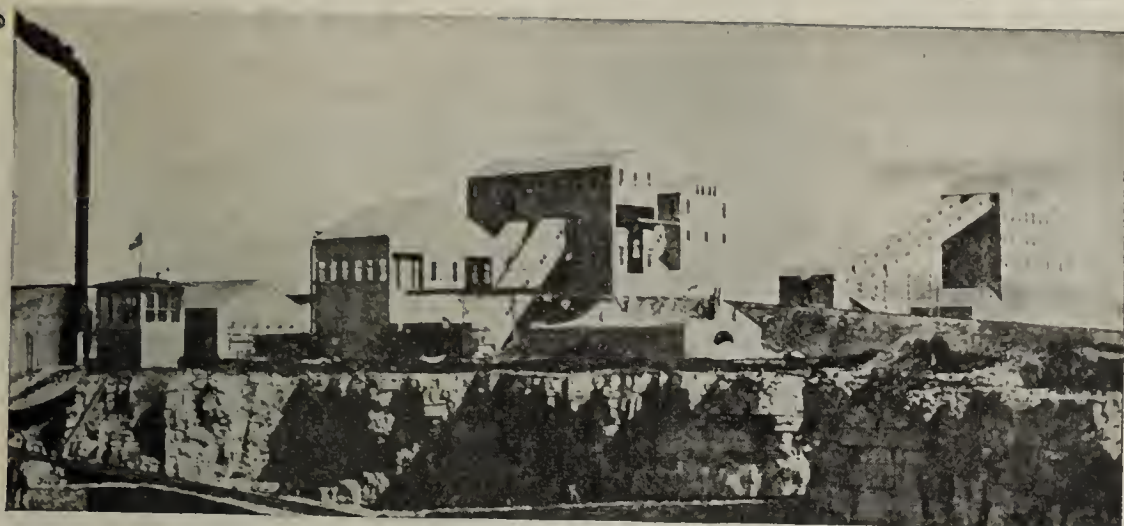
All sizes up to 7 foot retail at \$12.00 each.

All other sizes retail at \$15.00 each.

The Circle Molds vary in length from 22 to 28 inches, depending upon the diameter of its circumference.

In ordering Circle Molds always give the diameter of what you are going to build and I will then understand the kind of a circle mold you desire.

C. S. WERT, 602 North Main Street, Kendallville, Indiana, U.S.A.



Dolese & Shepard Co.'s Stone Crushing Plant, Gary, Ill. The largest in the world. Machinery throughout installed by us.

OLSON BROS. & CO.

Engineers and Contractors

Cement Mill Machinery Erected, Stone Crushing
Plants Equipped and Erected. :: :: ::

ALSO COMPLETE PLANTS FOR HANDLING
COAL, SAND, GRAVEL, ORES, ASHES, ETC.

MODERN POWER TRANSMISSION

Elevating and Conveying Machinery.

Tanks and Vats, Especially in Connection with Machinery

2418-22 Bloomingdale Ave., Chicago

THE PERFECTION CONCRETE MIXER

A Perfect Feed === A Thorough Mix

"We have three Perfection Concrete Mixers and they do the work in fine shape. I do not know of a mixer on the market that will do the work for the same money."

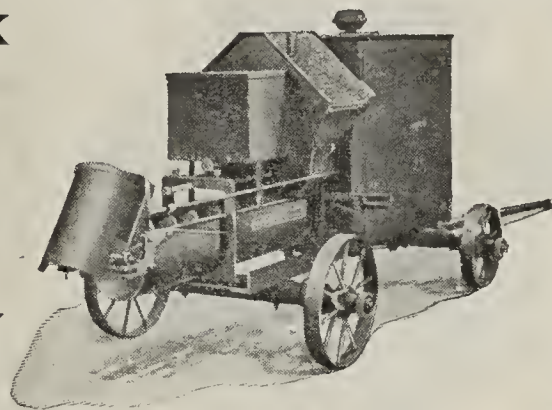
NEWELL CEMENT TILE CO.
Newell, Iowa

We have a 32-page catalog awaiting your request. It is absolutely free, shall we send it?

THE CEMENT TILE MACHINERY COMPANY

RATH STREET

WATERLOO, IOWA



JUST A REMINDER

ATLAS DRYERS—DRY NEARLY EVERYTHING

THE ATLAS DRYER CO., CLEVELAND, OHIO

"COMPETITION"

demand the exercise of the strictest economy in all lines of business. Our ability to take advantage of "Sheriffs," "Receivers" and "Bankrupt" Stocks makes it possible to quote you prices that mean a positive saving of from 30 to 75%. An inquiry will give us a chance to prove our assertions. Write today.

ROCK CRUSHERS.

1—9 x 15 Allis Chalmers Jaw Crusher.

ROCK DRILLS.

6—Ingersoll-Sargeant Rock Drills, size 3 3/4 inches.

6—Ingersoll-Sargeant Rock Drills, size 3 1/2 inches.

Fitted for steam or air.

HOISTING ENGINES.

1—12x16 double cylinder, heavy duty LIDGERWOOD hoisting engine.

1—6x8 Marine Iron Works double cylinder, single drums, reversible in steam chest.

PUMPS.

1—20x13x12 Wheeler & Tappen Duplex Pump.

1—14x8 1/2 x 10 Duplex Laidlaw-Dunn.

1—12x7x12 Duplex Smith Vall.

1—10x6x10 Duplex Dean.

5,000 rolls rubber, leather and canvas belting, structural iron, shafting, pulleys, couplings, steel wire and manila rope. Smoke stacks, corrugated roofing and siding, hose hydrants, tanks. We can save you money on anything you require.

STANDARD

IRON PIPE.

300,00 ft. 1 1/4 inch

150,000 ft. 1 1/2 inch

250,000 ft. 2 inches

12,000 ft. 10 inches

4,000 ft. 12 inches

30,000 ft. 8 in. Cast

Iron

300 ft. 24 in. Cast

Iron

IRON CASING.

35,000 ft. 1 3/4 inch

40,000 ft. 3 3/4 inches

60,000 ft. 3 3/4 inches

8,000 ft. 5 5/8 inches

9,000 ft. 6 1/4 inches

1,000 ft. 6 5/8 inches

1,250 ft. 8 1/4 inches

STRUCTURAL STEEL AND IRON.

The most complete line of Structural Steel and Iron in the city, consisting of I-beams, channels, angles, T's, columns, truss rods, joint anchors, girders, sill plates, sidewalk lights, coal-hole covers, new and relaying rails, bridge work, etc. We cut to any size, punch, rivet and fabricate as far as practical, and deliver all

ready to assemble, at a saving to you of 30 to 60 per cent. Send plan of the work you have in view and let us make you an estimate.

TANKS.

12—1,000 gallon capacity tanks.

42—1,500 gallon capacity tanks.

6—3,000 gallon capacity tanks.

15—3,600 gallon capacity tanks.

STEEL STORAGE TANKS.

Capacity, 4,500 to 6,500 gallons. These tanks were used only a short time in railroad service. Very heavy construction—1/4" steel with 5-16" heads; domes in proportion to size of tank, and fitted with 15" screwed manhole. We will give them rigid inspection and paint before shipment. Prompt shipment can be made from points South, East and West.

SEND FOR OUR NEW 500-PAGE CATALOG NO. 962.

A wonderful book of facts and information of the utmost value to everyone. Send to-day. It will cost you nothing.

CHICAGO HOUSE WRECKING CO. 35th, and Iron Sts., CHICAGO, ILL.

Kennedy Gyratory Crusher

The only Crusher built with a ball and socket eccentric which will lend itself to any change in the inclination of the main shaft. Improved hopper, more efficient dust collars.

— ALSO —

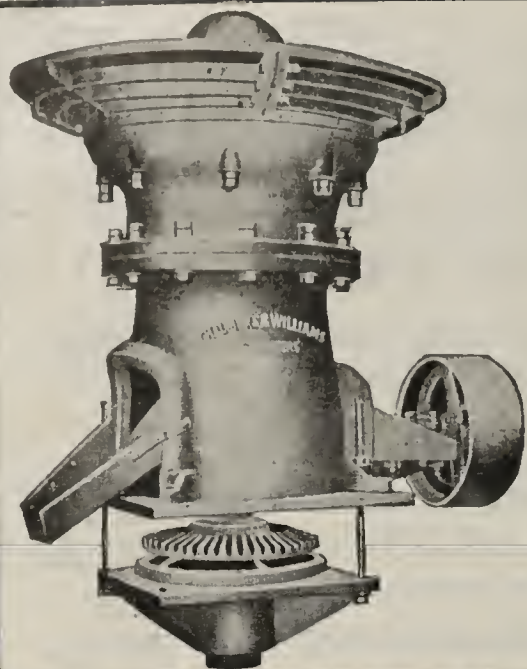
Cement Making Machinery

Kilns, Dryers, Tube Mills, Ball Mills, Elevators, Conveyors, Feeders, Revolving Screens and Crushing Rolls.

Chalmers & Williams Inc.

1927 Commercial National Bank Building, - - - Chicago

120 Liberty Street, New York



American Ring-Hammer Pulverizer

will pulverize

Cement, Clinker, Shale, Limestone, Coal, Etc.

30 days' working test at your works allowed. Machines guaranteed
All Grinding Parts Made of MANGANESE STEEL.

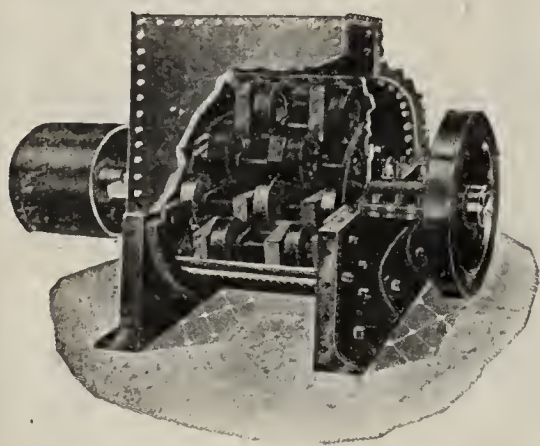
Write for particulars and circulars.

AMERICAN PULVERIZER CO.

410 JACCARD BUILDING



ST. LOUIS, MO.

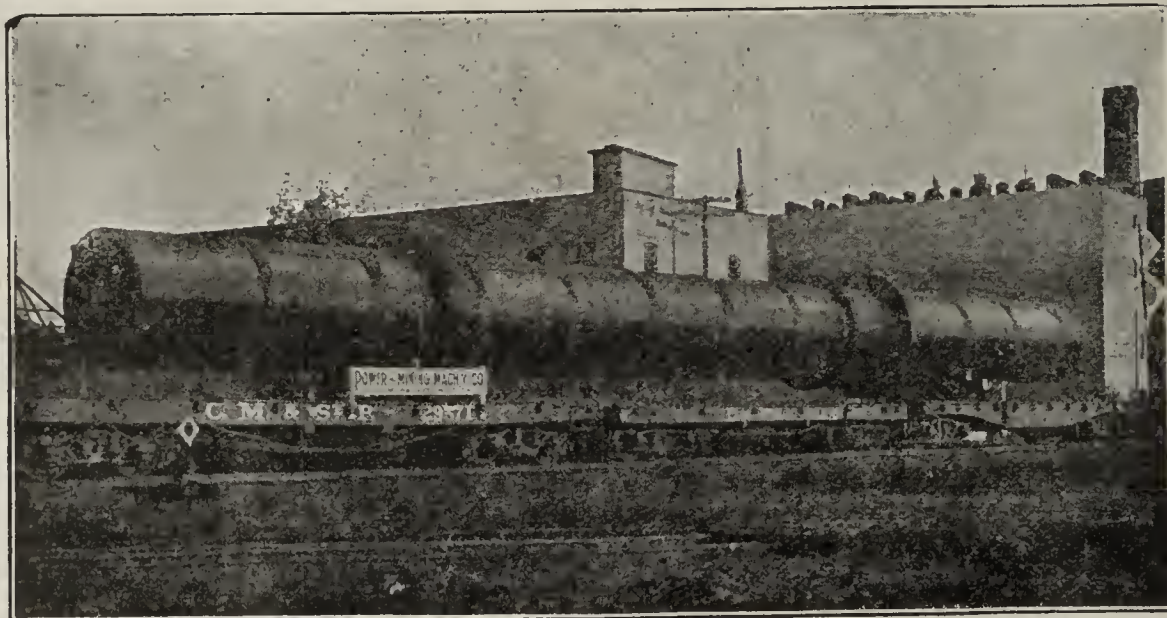


Six Sizes.

Cement Mill Machinery

A Complete Line of the Most Up-to-Date and Mechanically and Scientifically Correct Machinery for the Production of Cement by Either the Wet or Dry Process.

McCULLY CRUSHERS, SUPERIOR CRUSHING ROLLS, BALL-TUBE MILLS, BALL MILLS, COOLERS, DRYERS, KILNS, POWER TRANSMITTING MACHINERY, ETC.



Write for Catalogue No. 17.

Power & Mining Machinery Company

MILWAUKEE, WIS., U. S. A.

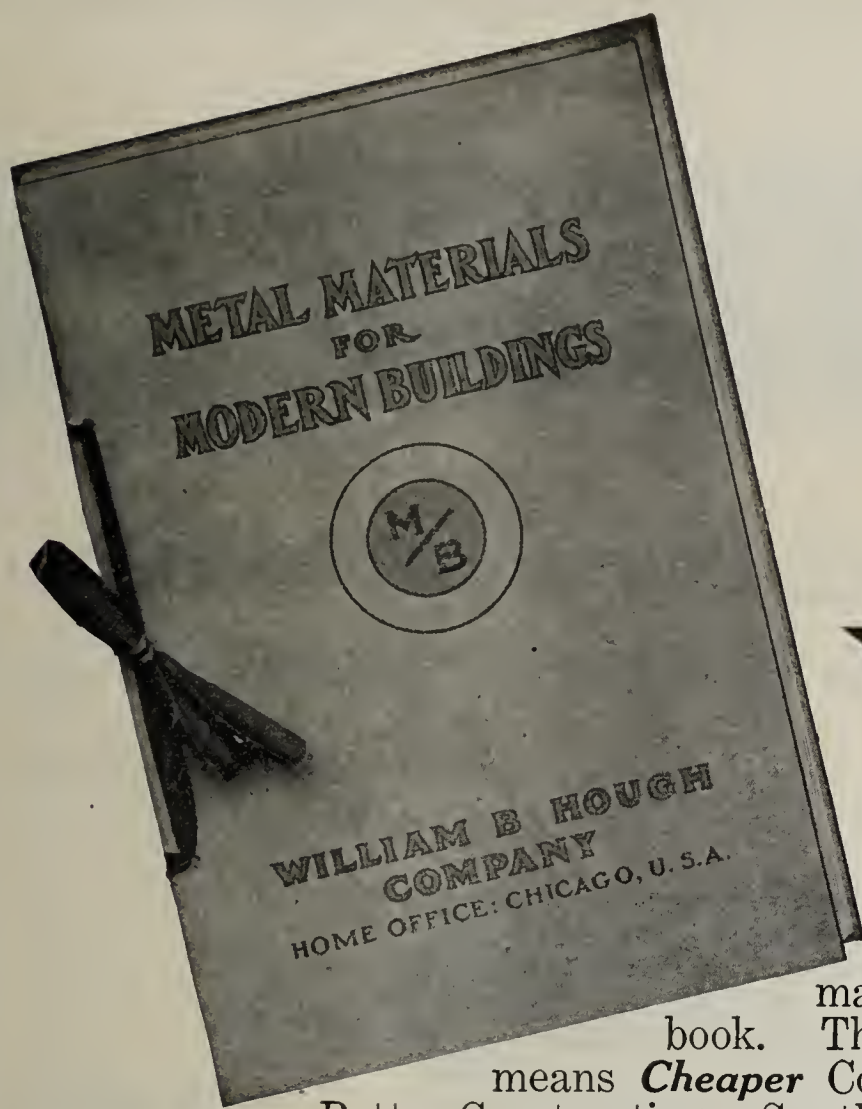
CHICAGO.

NEW YORK.

ATLANTA.

EL PASO.

SAN FRANCISCO.



Here's A Book

You Need It in Your Business

Ask—and It's Yours

Here's a Book of Progress—of new and better building ideas—of the latest and best developments in metal building specialties. *You ought to have a copy.* You need to be familiar with *all* of the improved building materials described and illustrated in this book. The up-to-date information it contains means *Cheaper* Construction, Quicker Construction, and Better Construction. So, then—*why not get it*—it's yours for the asking. Just ask for our book entitled—

“Metal Materials for Modern Buildings”

It shows you at a glance what great *improvements* are being made in metal building specialties—improvements that simplify and economize labor, save time and money, and result in more satisfactory construction.

It shows the new and improved styles of Corner Beads including a large variety of beads to meet various special conditions; the Hough Special Expanded Steel Lath which offers such big advantages and economies over all other metal laths; the new Securo Supporting Spacer for spacing, supporting and locking concrete reinforcing bars; the new Hough Adjustable Anchor for use in concrete construction; Furring Strips and other up-to-date metal specialties which you ought to know about.

Fill out the coupon below and allow us the pleasure of sending you, postpaid, a copy of our new book, “Metal Materials for Modern Buildings.”

William B.

Home Office

Monadnock Building, Chicago, U. S. A.

Hough Co.

Detroit; Minneapolis; Indianapolis; Des Moines
Warehouses at Chicago and other distributing points

William B. Hough Co.

Monadnock Bldg., Chicago, U. S. A.

Please send to me **FREE**, postpaid, a copy of your new book—“Metal Materials for Modern Buildings.”

My business is.....



Name.....

City..... State.....

Street and No.....

NOTE:—Write name and address as plainly as possible.

1234567

ALLIS-CHALMERS CO

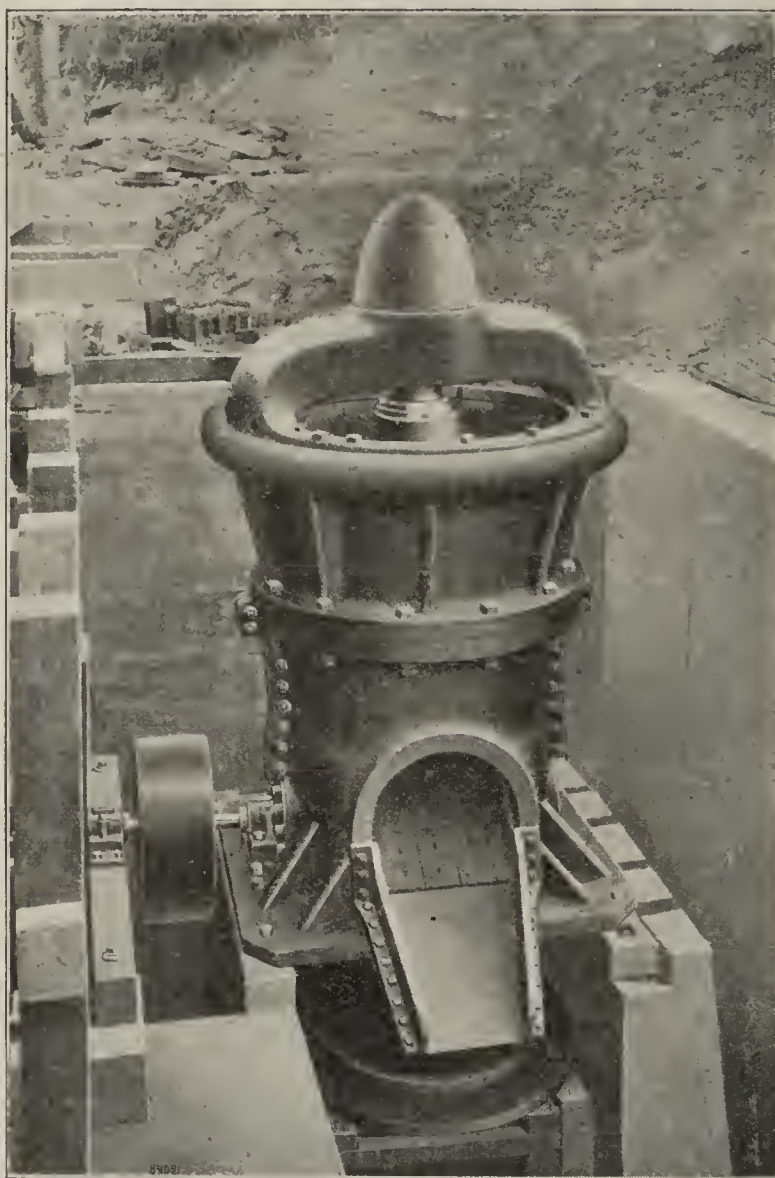
TWO MODEL STONE CRUSHING PLANTS

have recently been placed in operation by the Casparis Stone Company, one at Havre de Grace, Md., and the other at Pattersons Creek, W. Va.

Allis-Chalmers Company designed these plants and furnished the entire equipment, including the power generating apparatus and motors.

Each plant is equipped with a No. 21 Gates Breaker and arranged for eight No. 6 Style "K" Gates Breakers for rejections, together with necessary elevators and screens.

Power is supplied by a 600 K. W. Allis-Chalmers Steam Turbo-Generator, driving Allis-Chalmers induction motors.



The Receiving Opening of No. 21 Breakers admits any size of stone that can be passed through the standard dipper of a 100-ton steam shovel.

These machines break more and harder rock per horse power consumed than any other ever built.

Ask for information about Allis - Chalmers Crushing and Cement Making Machinery.

No. 21 Gates Breaker in the Pit at the Havre de Grace Plant of The Casparis Stone Company (taken during erection)

Offices in all the Principal Cities

GENERAL OFFICES

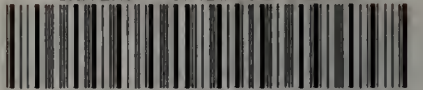
:: :: :: :: ::

MILWAUKEE, WIS.





UNIVERSITY OF ILLINOIS-URBANA



3 0112 051950407